

# ***PROPOSED B.S. DEGREE PROGRAM IN CHEMICAL AND BIOLOGICAL ENGINEERING***

Department of Chemical and Biological Engineering  
University of Colorado at Boulder

February 3, 2006

## **1. Description of the Proposed Program**

Faculty from the Department of Chemical and Biological Engineering (CBEN) at the University of Colorado at Boulder propose establishing a new B.S. degree program in Chemical and Biological Engineering. The proposed degree program would complement the CBEN department's current B.S., M.S., and Ph.D. degrees in Chemical Engineering.

The proposed Chemical and Biological Engineering degree program would expand the existing Bioengineering Option in the Chemical Engineering degree into a complete major program focused on the dynamic changes that are occurring at the interface of biology and engineering. CBEN currently has over 250 students enrolled in the undergraduate Chemical Engineering program. Approximately half of those students take all or part of the courses associated with the bioengineering program option, and students who have participated have been highly successful in finding employment or seeking further professional training (e.g., graduate school or medical school). The proposed degree program would offer an ideal opportunity for undergraduate engineering students to discover the importance and exciting advances made in the field of biological engineering and become fully trained in the techniques necessary to pursue a career in that field.

Colorado is an industrial and academic leader in the biological sciences and engineering fields. With the ever-increasing importance of these fields economically and socially with respect to quality of life, it is imperative that the state further improve its standing. To do so, we must continue to evolve our educational paradigm. The CBEN Department proposes to do exactly that by developing a broad-based program of Biological Engineering Education that will increase the number of qualified biological engineers trained in Colorado, enhance their training by affording every student a discovery-based research experience and training during their degree, provide an opportunity for increased biological training of other types of engineers, specifically non-majors with an interest in biological engineering, and improve the diversity of backgrounds of engineers in these areas. The CBEN department at UCB has the experienced faculty along with a history of interactions with various biological disciplines (e.g., Biochemistry, Molecular, Cellular, and Developmental Biology (MCDB), Pharmacy, Medicine, and Dentistry), and with industry, to lead a degree program that will provide a highly educated workforce for the dynamic chemical and biological engineering industry. Specifically, this proposal aims to build an educational program within the Department of Chemical and Biological Engineering at the University of Colorado that will serve as a center of excellence for educating students and integrating education and visionary research in biological engineering.

## **2. Proposed Program Goals**

The primary educational objective of an undergraduate program in Chemical and Biological Engineering is that the alumni achieve rewarding careers in chemical and biological engineering or related fields. To achieve this, graduates of the Chemical and Biological Engineering program will have acquired the ability and skills to:

- apply knowledge of mathematics, science, and engineering;
- design and conduct experiments, and analyze and interpret data;
- use modern chemical and biological engineering tools, skills, and methods for engineering practice;
- design processes and systems to meet desired performance specifications;
- identify, formulate and solve engineering problems;
- understand professional and ethical responsibilities;
- communicate effectively in oral and written forms;
- function effectively on multidisciplinary teams;
- understand the impact of biological engineering solutions in global and societal contexts;
- know contemporary engineering issues; and
- recognize the need for and have an ability to engage in lifelong learning.

The CBEN Department will strive to provide students with the knowledge, training, and opportunity to achieve the primary educational objective of rewarding careers in chemical and biological engineering or related fields by establishing the following specific goals:

- educate students in chemical and biological engineering fundamentals and practice;
- train students in chemical and biological process and product design;
- train students in critical thinking and in the identification, formulation, and solution of open-ended engineering problems;
- help students be aware of their responsibility to conduct ethical, safe, and environmentally-conscious engineering;
- train students to be good communicators and function effectively as individuals and in teams;
- provide students with knowledge of contemporary issues and understanding of the impact of engineering practices in global and societal contexts; and
- teach students the necessity for and tools for continued, lifelong learning.

## **3. Student Demand for Proposed Program**

Student interest in bioengineering is high and consistent as over the last few years enrollment in bioengineering courses in the College of Engineering and Applied Science at CU-Boulder has continued to increase. The CBEN Department has had a high number of students in its bioengineering course offerings, with steadily increasing enrollment, and provides an ideal environment in which new Chemical and Biological Engineering courses have been successfully developed. Since the Department's name change to Chemical and Biological Engineering in July 2003, the undergraduate enrollment has increased from 201 students in Fall 2002 to 265 in Fall 2005. Despite this 32% increase in Chemical Engineering enrollment, the College of Engineering and Applied Science as a whole has seen only a 2% enrollment increase in the same time period. An informal poll of freshman Chemical Engineering students in January 2006

found that 50% of the 70 students surveyed would switch to a Chemical and Biological Engineering major if given the option.

The CBEN Department's previous efforts in the Biological Engineering area also demonstrate need for a Chemical and Biological Engineering program. The Department has historically had a bioengineering option associated with its undergraduate Chemical Engineering degree. Approximately half of the students take all or some of the classes associated with this option, and students who have participated have been highly successful in finding employment. Among the 37 May 2005 B.S. Chemical Engineering graduates, 6 students (16%) fully completed the required coursework for the bioengineering option, while an additional 10 students (27%) were within 1 to 2 courses of completing the option. The strong interest of Chemical Engineering students in biology and chemistry is also corroborated by 9 of the 37 students (24%) earning minors in Biochemistry, 2 majors in Biochemistry, and 2 students completing a second major in Biology (1 in Molecular, Cellular and Developmental Biology and 1 in Environmental, Population, and Organismic Biology, now Ecology and Evolutionary Biology).

A degree program in Chemical and Biological Engineering would serve the interests of the students of the University of Colorado at Boulder, both those who are pursuing a major in the field and non-majors interested in taking the additional Chemical and Biological Engineering courses offered as part of the degree program.

Table 1 documents the anticipated enrollment in the Chemical and Biological Engineering B.S. degree program. At full establishment of the program, we expect approximately 125 students to be enrolled, with 30 graduates per year. These estimates are based on enrollment increases in Chemical Engineering since the department name change from Chemical Engineering to Chemical and Biological Engineering in 2003, and interest of current students in Chemical Engineering.

#### **4. Workforce Demand for Proposed Program**

In February, 2004, the U.S. Department of Labor reported that the number of bioengineering related jobs will increase by 26.1% through 2012, while engineering jobs in general are predicted to increase by only 7.8% and all jobs by just 14%. The report attributed the rapid rise in biomedical engineering jobs in part to an aging U.S. population and the increasing demand for improved medical devices and systems<sup>1</sup>. The Colorado Business Magazine (January 19, 1997) reported that the bioengineering industry was one of the largest and fastest growing areas of the Colorado economy. At that time, it had already accounted for 10% of the state's manufacturing base.

In March 2003, the Colorado Biotechnology Council released its blueprint for the next 3-5 years for the state to boost its biotechnology industry (*Colorado's Place in the Sun: A Bioscience Future, An Action Plan to Grow Colorado's Bioscience Cluster*, March 2003). The focus was to create more Colorado biotechnology jobs, and this can only be successful with a corresponding focus on educational programs to train students for the jobs. The report found that:

Colorado's research and testing (biotechnology) industry has experienced astonishing growth, nearly doubling in employment from 1998 until 2002. In addition to outpacing all other Colorado bioscience subsectors, growth in

---

<sup>1</sup> The Whitaker Foundation: <http://www.whitaker.org/glance/outlook2012.html>

research and testing, which experienced a 95 percent growth in employment between 1998 and 2002, is well above the national growth rate of 34 percent during the same time period.

Graduates of the Chemical and Biological Engineering degree program would be expected to fit well into the biotechnology industry, with the knowledge and hands-on laboratory experiences the degree program would give them. The need for students trained in this manner is especially important given the report's additional conclusion that:

For Colorado to fully leverage its areas of key bioscience research strengths, enhanced capabilities in not only computation biology but in other areas such as bioengineering will be needed.

The Chemical and Biological Engineering Department at UCB was noted in the report for its exceptional research in the polymeric biomaterials arena and the Center for Pharmaceutical Biotechnology, which, in conjunction with the University of Colorado School of Pharmacy, has fostered excellent research and built strong industrial relationships.

An NSF study<sup>2</sup> in 1998 found that around 60% of Colorado-educated scientists and engineers remained to work in the state after graduation. The study also found Colorado to be in the top 25% of states importing science and engineering graduates.

The Denver Business Journal (July 8, 2002) reported that three-fourths of the nation's biotechnology firms are located in 9 of the nation's metropolitan areas; Colorado ranked 14<sup>th</sup> with approximately 50 biotech companies. The motivations to join the top 9 players in this area are its high paying jobs and huge potential economic impact. Universities with outstanding research and technology transfer are key. The degree of commercialization activity is what distinguishes the top 9 big centers from the others. In 2000, 8 of the 9 biotech centers had university programs that drew in \$500M in funding from NIH. This level of federal funding, coupled with excellent technology transfer to start-up companies, would dramatically impact the state's economy in multiple ways. The key is to invest and grow research and education in these areas at our best institutions.

At the University of Colorado at Boulder, royalty income in the biotechnology area (Chemistry and Biochemistry, MCDB, and Chemical and Biological Engineering) from 1996-2005 was \$23M. Further, the biotechnology intellectual property has substantially contributed to 111 current licenses and 15 current start-up companies from CU.

The proposed program is focused on providing engineers who are prepared to fill the indicated increase of more than 25% in biological engineering jobs estimated over the next seven years. Our Biotechnology Leadership Training Program, executed jointly with the Molecular, Cellular, and Developmental Biology and Chemistry and Biochemistry Departments, has been tremendously successful at educating, training, and industrially placing students for the last 15 years. This initiative incorporates educational courses, industrial internships, and discovery-based research experiences into an interdisciplinary program. Students have been placed with a wide range of companies including the following Colorado companies: NIST, Agilent, Atrix, Amgen,

---

<sup>2</sup> Louis Tornatzky, Denis Gray, Stephanie Tarant, and Julie Howe. *Where Have All the Students Gone: Interstate Migration of Recent Science and Engineering Graduates*. Southern Technology Council, February 1998.

Array Biopharma, Baxter, Biostar, Genomica, Gilead, COBE Cardiovascular, Prologo, Ribozyme Pharmaceuticals, Roche, and Somalogic. These companies will each be an important employer of students in the new CBEN degree program.

In addition to industrial employment, the Chemical and Biological Engineering degree program is designed to meet all academic requirements for admission to top Biomedical Engineering and Bioengineering graduate programs, joint MD/PhD programs, and medical schools. The opportunity for many students to have experience in a research laboratory as undergraduates will further qualify them for graduate study.

## **5. Role and Mission Criteria**

Colorado Revised Statute 23-20-101(1)(a) state that the role and mission of the university of Colorado at Boulder is as follows: The Boulder campus of the university of Colorado shall be a comprehensive graduate research university with selective admission standards. The Boulder campus of the university of Colorado shall offer a comprehensive array of undergraduate, masters, and doctoral degree programs. The Boulder campus of the university of Colorado has exclusive authority to offer graduate programs in law. The Colorado commission on higher education, in consultation with the board of regents, shall designate those graduate level programs that are the primary responsibility of the Boulder campus of the university of Colorado. The university has the responsibility to provide on a statewide basis, utilizing when possible and appropriate the faculty and facilities of other institutions, those graduate level programs. The commission shall include in its funding recommendations a level of general fund support for these programs.

The proposed Chemical and Biological Engineering degree program would enhance the array of programs offered by the University of Colorado by offering students the option to pursue studies in the growing biotechnology field. The Chemical and Biological Engineering degree program will enhance both student interest and career opportunities while providing an improved, well-trained work force in support of Colorado's biotechnology industry. In addition, the Chemical and Biological Engineering degree program will focus on active learning (involving students through hands-on laboratory experiences in the classroom) and providing research opportunities for all undergraduate students, two of the defined missions of the University of Colorado.

The Chemical and Biological Engineering undergraduate degree would help achieve CU's goal of keeping the best students in Colorado institutions by providing the only degree program in the state in the burgeoning field of bioengineering. The high demand for bio-trained engineering students, both at Colorado employers and throughout the nation, and the national attention and financial support being given to research in the field, suggest that UCB and the State of Colorado would benefit greatly from an undergraduate major in this field. Drawing on the strong chemical and biological engineering research programs in the CBEN department, students can be educated to enter this profession locally.

## **6. Duplication with Programs at Other Colorado Institutions**

Several universities in Colorado offer the option of a minor or special study in the field of bioengineering or biological sciences; however, no schools offer major degree programs in Bioengineering or closely related fields. The University of Denver has a major in

Bioinformatics offered through their Computer Science department. However, students in the program take 40 hours of computer science courses, 28-30 hours of biology, 22 hours of chemistry, and only 8 hours of mathematics. Experimental engineering and design, as well as calculus, are not part of the curriculum at UD, but they are critical components of the proposed Chemical and Biological Engineering degree program.

Minors or special study options in Biological Sciences or Bioengineering are currently offered at a number of Colorado schools, including through the CBEN Department at UCB. Colorado State University offers an interdisciplinary certificate in Biomedical Engineering for undergraduate students, and a minor in Biomedical Sciences, with a strong anatomy emphasis, through the College of Veterinary Medicine and Biological Sciences. Colorado School of Mines has an interdisciplinary minor or “area of special interest” in Bioengineering and Life Sciences. The University of Colorado at Boulder College of Engineering and Applied Science has biological-based specialization options for several majors, including Aerospace Engineering Sciences, Applied Mathematics, Chemical Engineering, Electrical Engineering, Electrical and Computer Engineering, and Mechanical Engineering. The proposed degree program would complement the biological option offerings of the other departments at UCB. Students majoring in Chemical and Biological Engineering would take technical electives in other departments to supplement the required curriculum, and the increased course offerings of the Chemical and Biological Engineering Department would provide students completing biological engineering options in other departments the choice of more elective courses to enhance their bioengineering education.

The proposed Chemical and Biological Engineering degree program at the University of Colorado at Boulder would be unique in the state of Colorado in offering an educational infrastructure for educating students and integrating education and visionary research in areas that incorporate biology and engineering principles. The strong engineering background of the students would prepare them well for careers in the pharmaceutical, medical instrumentation, biotechnology, biochemical or other more traditional chemical engineering industries while still offering a thorough grounding for pursuing advanced education in Medical Sciences, Chemical Engineering, Biomedical Engineering, or other similar programs. Exceptional research in biological engineering by many of the faculty in the CBEN Department would offer a unique opportunity for large numbers of undergraduate students to be involved in hands-on laboratory experiences.

## **7. Statutory Requirements**

The proposed program conforms to all statutory requirements.

## **8. Admission, Transfer and Graduation Requirements**

### ***a. Admissions Requirements***

University of Colorado at Boulder criteria apply for admissions.

### ***b. Requirements for Transfer Students***

In addition to University admissions criteria for transfer students, standard College of Engineering and Applied Science admission guidelines also apply. Chemical and

Biological Engineering transfer students should have completed two semesters of college chemistry before enrolling at CU-Boulder.

### ***c. Enrollment Restrictions***

Enrollment restrictions would be implemented only if necessary based on availability of resources.

### ***d. Continuation and Graduation Requirements***

Graduation with a B.S. degree in Chemical and Biological Engineering would require the completion of the curriculum presented below, consisting of 128 semester credit hours with a University of Colorado cumulative grade point average of 2.00 or higher. A grade of C- or better would be necessary in all required Chemical and Biological Engineering courses with a cumulative grade point average in Chemical and Biological Engineering courses of 2.00 or better.

Good academic standing and academic probation and suspension would be determined by the policies of the College of Engineering and Applied Science at UCB.

## **9. Curriculum Description and Assessment Process**

The learning goals of the Chemical and Biological Engineering degree program are to be met through lecture, laboratory and capstone design coursework. The program is designed to give students knowledge of engineering fundamentals and problem solving with specific emphasis on chemical and biological engineering problems and practices.

### ***a. Proposed Program Requirements***

Requirements for a B.S. degree would include completion of 128 semester hours, as required for engineering accreditation, of approved core and elective courses with a minimum 2.00 grade point average.

The 128 required hours are divided between 98 hours of required technical courses, 12 hours of biological technical electives, and 18 hours of humanities and social science coursework (6 hours must be 3000 level or higher). Of the 98 hours of required technical courses, 19 are mathematics and computing, 21 are in chemistry and biochemistry, 7 are biology, 9 are physics, and 42 are in Chemical and Biological Engineering.

Included in the Chemical and Biological Engineering courses is Introduction to Chemical Engineering (CHEN 1300, 1 credit hour), a course only required for Chemical and Biological Engineering majors in their freshman year. For transfer students or those changing to a Chemical and Biological Engineering major after their freshman year, this course is not required, bringing the required Chemical and Biological Engineering hours to 41 and the biological technical elective hours to 13.

As part of their 128 total hours, students would complete 10 hours of chemistry, biology, and Chemical and Biological Engineering laboratories, as well as 2 hours of an industry-supplied and guided, teamwork capstone design project. No field experience would be required, however, students could elect and would be highly encouraged to participate in

existing CBEN department study abroad, cooperative education, service learning outreach, and undergraduate research experiences.

An important component to the undergraduate education experience in the CBEN Department is twice-yearly mandatory advising for students, conducted by department faculty members.

The policies of the College of Engineering and Applied Science will be followed as far as credit-toward-degree is concerned for Presidents' Leadership Class, ROTC, and other courses.

The proposed B.S. in Chemical and Biological Engineering would fulfill all academic requirements for admission to Ph.D. level study at any of the top three Biomedical Engineering graduate programs (Johns Hopkins University, University of California-San Diego, and Georgia Institute of Technology), including courses in biology, organic chemistry, physical chemistry, biochemistry, calculus, differential equations, and calculus-based physics.

When considering similar programs in the field, it is important to differentiate between Biomedical Engineering programs and Bio- and Biochemical Engineering programs. Biomedical Engineering undergraduate programs, such as the highly ranked programs at Johns Hopkins, Duke and the University of California-San Diego, include limited chemistry courses (general chemistry plus maybe one other course) and have a strong focus on medical instrumentation and medical device design. The programs are linked to the university medical schools, rather than a strong engineering school. Many graduates from these programs go on to graduate study or medical school (e.g. one-third of Duke's graduates go to graduate school and another third go to medical school). Compared to other Bioengineering and Biochemical Engineering degree programs (e.g. University of Pennsylvania, University of Washington, University of Illinois at Chicago, Pennsylvania State University, Oregon State University, Lehigh University and the University of Illinois at Urbana-Champaign) the proposed Chemical and Biological Engineering degree program has slightly more chemistry (general, organic, and physical chemistry instead of general and organic or physical chemistry) and courses in mechanics and electrical engineering would be electives in the proposed program, rather than required courses. The proposed program is quite similar to those offered by the Department of Chemical and Biochemical Engineering at Rutgers University and the Chemical and Biomolecular Engineering degree program at Johns Hopkins University, with Chemical Engineering fundamentals interwoven with biology, biochemistry, bioengineering principles and biological laboratory practices. Graduates of such programs are prepared for careers in medical instrumentation, pharmaceuticals, biotechnology, and biochemical industries, as well as medical school (see pre-medicine curriculum), graduate study, and traditional chemical engineering fields.

### ***b. Program Courses***

#### Existing Courses (Required):

APPM 1350	Calculus 1 for Engineers
APPM 1360	Calculus 2 for Engineers
APPM 2350	Calculus 3 for Engineers
APPM 2360	Introduction to Linear Algebra and Differential Equations

CHEM 1221	General Chemistry Laboratory for Engineers
CHEM 3311	Organic Chemistry 1
CHEM 3321	Laboratory in Organic Chemistry 1
CHEM 3331	Organic Chemistry 2
CHEM 3341	Laboratory in Organic Chemistry 2
CHEM 4521	Physical Chemistry for Engineers
CHEM 4711	General Biochemistry 1
CHEN 1211	General Chemistry for Engineers
CHEN 1300	Introduction to Chemical Engineering
CHEN 2120	Chemical Engineering Material and Energy Balances
CHEN 2810	Biology for Engineers
CHEN 3010	Applied Data Analysis
CHEN 3130	Chemical Engineering Laboratory 1
CHEN 3200	Chemical Engineering Fluid Mechanics
CHEN 3210	Chemical Engineering Heat Transfer
CHEN 3320	Chemical Engineering Thermodynamics
CHEN 4090	Chemical Engineering Undergraduate Seminar
CHEN 4520	Chemical Process Synthesis
CHEN 4570	Instrumentation and Process Control
GEEN 1300	Introduction to Engineering Computing
MCDB 2150	Principles of Genetics
PHYS 1110	General Physics 1
PHYS 1120	General Physics 2
PHYS 1140	Experimental Physics 1
WRTG 3030	Writing on Science and Society

New Courses (Required):

CHEN 2XXX	Foundations of Bioengineering Laboratory
CHEN 3XXX	Biokinetics

Modified Courses:

CHEN 2XXX	Foundations of Bioengineering: current elective course, becomes required course taught every year, 1 credit hour corresponding laboratory to be developed
CHEN 4530	Chemical Engineering Design Project: currently traditional chemical engineering and bioengineering projects offered; Chemical and Biological Engineering degree students would be required to complete a bioengineering project
CHEN 4800	Bioprocess Engineering: Currently elective course taught every two years, becomes required course taught every year
CHEN 4820	Biochemical Separations: Currently elective course taught every two to three years, becomes required course taught every year
CHEN 4830	Chemical and Biological Engineering Laboratory 2: current Chemical Engineering Laboratory 2 format would be maintained with Biological Engineering experiments replacing traditional Chemical Engineering experiments

CHEN 4XXX	Pharmaceutical Biotechnology: currently elective course taught every two years, becomes required course taught every two years
CHEN 4XXX	Biomaterials: currently elective course, becomes required course taught every two years

Humanities and social science elective courses must be from the approved list of the College of Engineering and Applied Science to fulfill graduation requirements.

Technical Electives must meet current defined requirements of falling into the following general categories: most courses not in the required course list taught by the engineering departments in the College of Engineering and Applied Science; many courses taught by Computer Science and Engineering Management; nearly any higher-level mathematics, physics, or chemistry course not in the set of required courses; virtually any course in the physical sciences, e.g., biology, geology, astro-physics, and physical geography; quantitative methods courses and other sufficiently rigorous courses in the social sciences, e.g., economics, psychology, and human geography; many courses taught by the Leeds School of Business; and independent study courses of a technical nature.

### ***c. Sample Curriculum***

A sample curriculum to be followed by Chemical and Biological Engineering majors is presented below. The curriculum combines the above listed required science, math, and engineering courses with electives in humanities and social sciences, and technical electives.

In addition to the basic degree program in Chemical and Biological Engineering, a Pre-medicine Curriculum is laid out, designed to guide students in combining the requirements for the Chemical and Biological Engineering degree along with the typical requirements for admission to medical schools in the United States. The Pre-medicine Curriculum requires four more credit hours than the basic degree program, and specifies that two Humanities and Social Science electives be a literature sequence. A course in expository or creative writing is recommended for medical school admission, but does not count as a Humanities and Social Science elective. Two semesters of biology and biology laboratories (Biology for Engineers and MCDB 1151, 2150, and 2151) are included in the curriculum.

## Chemical and Biological Engineering Curriculum

### Freshman Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
APPM 1350	Calculus 1	4	APPM 1360	Calculus 2	4
CHEM 1211	Chem for Engrs	3	PHYS 1110	Physics 1	4
CHEM 1221	Chem Lab Engrs	2	CHEM 1300	Intro to Chem. Eng.	1
GEEN 1300	Computing	3	MCDB 2150	Genetics	3
CHEM 2810	Biology for Engrs	3	H&SS	Elective	3
		<u>15</u>			<u>15</u>

### Sophomore Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
APPM 2350	Calculus 3	4	APPM 2360	Lin Algebra/ODE	4
CHEM 3311	Organic Chem 1	4	PHYS 1120	Physics 2	4
CHEM 3321	Organic Lab1	1	PHYS 1140	Exper. Physics	1
CHEM 2XXX	Foundat. in BioE	3	CHEM 4521	PChem for Engrs	3
CHEM 2XXX	Foundations Lab <sup>#</sup>	1	CHEM 3200	Fluid Mechanics	3
CHEM 2120	Matl & Energy Bal	3	H&SS	Elective	3
		<u>16</u>			<u>18</u>

### Junior Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
CHEM 3320	Thermodynamics	3	CHEM 3XXX	Biokinetics	3
CHEM 3010	Applied Data Anal	3	CHEM 3130	Chem Eng Lab 1	2
CHEM 3210	Heat Transfer	3	CHEM 4611	Survey Biochem <sup>+</sup>	3
CHEM 3331	Organic Chem 2	4	CHEM 4820	Bioseparations	3
CHEM 3341	Organic Lab2	1	CHEM 4XXX	Biomaterials*	3
WRTG 3030	Writing	3	H&SS	Elective	3
		<u>17</u>			<u>17</u>

### Senior Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
CHEM 4830	CBEN Lab 2	2	CHEM 4530	Design Project	2
CHEM 4090	Senior Seminar	1	CHEM 4570	Process Control	4
CHEM 4520	Process Synth.	3	CHEM 4XXX	Pharm. Biotech.*	3
CHEM 4800	Bioprocess Engg	3	Tech	Elective	3
Tech	Elective	3	H&SS	Elective	3
H&SS	Elective	3			<u>15</u>
		<u>15</u>			<u>15</u>
					<b>Total Credit Hours 128</b>

\* Pharmaceutical Biotechnology and Biomaterials would be offered in alternating years; they would be interchangeably taken in the springs of the junior and senior years.

# Until the Foundations of Engineering Laboratory is developed, students would take their choice of MCDB 1151 or MCDB 2151 in the fall or spring, respectively, of their freshman year.

+ CHEM 4711: Biochemistry 1 may be taken in place of CHEM 4611: Survey of Biochemistry by students taking the Biochemistry sequence as part of a Biochemistry minor.

Note: Bioprocess Engineering (CHEM 4800) has a prerequisite of Biokinetics.

## Chemical & Biological Engineering Curriculum – Pre-Medicine Curriculum

### Freshman Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
APPM 1350	Calculus 1	4	APPM 1360	Calculus 2	4
CHEM 1211	Chem for Engrs	3	CHEM 1131	General Chem 2	5
CHEM 1221	Chem Lab Engrs	2	PHYS 1110	Physics 1	4
GEEN 1300	Computing	3	CHEM 1300	Intro to Chem. Eng.	1
CHEM 2810	Biology for Engrs	3	MCDB 2150	Genetics	3
MCDB 1151	Intro Cell Biol Lab	1	MCDB 2151	Genetics Lab	1
16			18		

### Sophomore Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
APPM 2350	Calculus 3	4	APPM 2360	Lin Algebra/ODE	4
CHEM 3311	Organic Chem 1	4	PHYS 1120	Physics 2	4
CHEM 3321	Organic Lab1	1	PHYS 1140	Exper. Physics	1
CHEM 2XXX	Foundat. in BioE	3	CHEM 4521	PChem for Engrs	3
CHEM 2XXX	Foundations Lab <sup>#</sup>	1	CHEM 3200	Fluid Mechanics	3
CHEM 2120	Matl & Energy Bal	3	H&SS	Literature Elective	3
16			18		

### Junior Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
CHEM 3320	Thermodynamics	3	CHEM 3XXX	Biokinetics	3
CHEM 3010	Applied Data Anal	3	CHEM 3130	Chem Eng Lab 1	2
CHEM 3210	Heat Transfer	3	CHEM 4611	Survey Biochem <sup>+</sup>	3
CHEM 3331	Organic Chem 2	4	CHEM 4820	Bioseparations	3
CHEM 3341	Organic Lab2	1	CHEM 4XXX	Biomaterials <sup>*</sup>	3
WRTG 3030	Writing	3	H&SS	Literature Elective	3
17			17		

### Senior Year

<u>Fall Semester</u>			<u>Spring Semester</u>		
CHEM 4830	CBEN Lab 2	2	CHEM 4530	Design Project	2
CHEM 4090	Senior Seminar	1	CHEM 4570	Process Control	4
CHEM 4520	Process Synth.	3	CHEM 4XXX	Pharm. Biotech. <sup>*</sup>	3
CHEM 4800	Bioprocess Engg	3	H&SS	Elective	3
ENGL 1191	Intro Creative Wrtg	3	H&SS	Elective	3
H&SS	Elective	3	15		
15			15		
					Total Credit Hours 132

\* Pharmaceutical Biotechnology and Biomaterials would be offered in alternating years; they would be interchangeably taken in the springs of the junior and senior years.

# Until the Foundations of Engineering Laboratory is developed, MCDB 1151 and 2151 would satisfy this requirement, and only 131 total credit hours would be required.

+ CHEM 4711: Biochemistry 1 may be taken in place of CHEM 4611: Survey of Biochemistry by students taking the Biochemistry sequence as part of a Biochemistry minor.

*Note:* Bioprocess Engineering (CHEM 4800) has a prerequisite of Biokinetics.

#### ***d. Assessment Plan***

The student goals of the Chemical and Biological Engineering program are to give students the ability and skills to:

- apply knowledge of mathematics, science, and engineering;
- design and conduct experiments, and analyze and interpret data;
- use modern engineering tools, skills, and methods for engineering practice;
- design processes and systems to meet desired performance specifications;
- identify, formulate and solve engineering problems;
- understand professional and ethical responsibilities;
- communicate effectively in oral and written forms;
- function effectively on multidisciplinary teams;
- understand the impact of engineering solutions in global and societal contexts;
- know contemporary issues; and
- recognize the need for and have an ability to engage in lifelong learning.

To ensure the above goals are being met by the program, several assessment strategies will be employed. An emphasis will be placed on a continuous evaluation cycle with quantitative and qualitative assessment methods employed to assess the program's success in meeting the above objectives. Quantitative methods include student and faculty attitude surveys, and faculty course questionnaires carefully tailored to insure that our learning goals are met. In addition, course assessment questionnaires that map to the above eleven program outcomes and assessment criteria have been developed and will be used for new courses as well as previous elective courses, now required. Qualitative methods include open-ended survey questions and focus groups for both students and faculty. Exit surveys will be administered to all graduates of the department and will be used as part of the summative evaluation.

Assessment results will be documented and presented at semester-end sessions during which the departmental curriculum committees will evaluate program results in light of objectives. Program participants will also evaluate the results at the end of each semester, and lessons learned will inform the program as it evolves. In addition, results will be presented at the yearly Executive Advisory Council. To determine long-term project outcomes, students' educational and career choices will be monitored via annual updates from CU's central student tracking office and an annual alumni survey to track students' future career choices. Faculty and student attitudes toward curricular changes will be tracked via semester-end pre- and post-tests, and student enrollment in biological engineering classes. Assessment methods will target specific performance criteria designed to ascertain whether program objectives have been met.

### **10. Professional Requirements or Evaluations**

#### ***a. Regional or Professional Accreditation***

The University of Colorado at Boulder is accredited under the North Central Association of Colleges and Schools. Accreditation for the Chemical and Biological Engineering degree program would also be sought with the Accreditation Board for Engineering and Technology (ABET) as a chemical engineering program, through which the B.S. Chemical Engineering degree program is currently accredited.

ABET defines the following restrictions on Chemical Engineering program curricula:

The program must demonstrate that graduates have: thorough grounding in chemistry and a working knowledge of advanced chemistry such as organic, inorganic, physical, analytical, materials chemistry, or biochemistry, selected as appropriate to the goals of the program; working knowledge, including safety and environmental aspects, of material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and stage-wise separation operations; process dynamics and control; process design; and appropriate modern experimental and computing techniques.<sup>3</sup>

The Chemical and Biological Engineering curriculum proposed above is designed to meet and/or exceed these requirements in all content areas.

### ***b. Timetables to Meet Requirements***

ABET does an initial accreditation evaluation only after the program has its first class of graduates. With the proposed program allowing current freshman to transfer into the degree program, an accreditation evaluation would be requested by January 31 of the third academic year of operation, for an accreditation visit during the fall of the fourth academic year of the program. This would follow graduation of the first class at the end of the third academic year.

### ***c. Program Faculty***

Faculty for the Chemical and Biological Engineering degree program would be current faculty of the Chemical and Biological Engineering Department as listed below. Biological engineering courses will be developed by those faculty who have strong research interests in and previous experience with the bioengineering field. Short vitae for all faculty expected to regularly teach in this degree program are included in the Appendix.

Chemical and Biological Engineering Faculty in Fall 2005

<b>Name</b>	<b>Position</b>	<b>Specialization Areas</b>
Kristi Anseth	Tisone Professor	biomaterials, polymers, tissue engineering, drug delivery
Chris Bowman*	Clark Professor	biomaterials, polymers, reaction engineering
Stephanie Bryant	Assistant Professor	functional tissue engineering, biomaterials, photopolymerization
David Clough <sup>#</sup>	Professor	process control, optimization
Robert Davis**	Patten Professor	biotechnology, fluid mechanics, membrane separations
Janet deGrazia	Senior Instructor	
John Falconer <sup>##</sup>	Professor	heterogeneous catalysis, membranes
Steve George	Professor	surface chemistry and thin films
Ryan Gill	Assistant Professor	evolution/inverse metabolic engineering, genomics

<sup>3</sup> Criteria for Accrediting Engineering Programs: Effective for evaluations during the 2005-2006 accreditation cycle. Available at: [www.abet.org](http://www.abet.org).

Doug Gin	Associate Professor	polymer science, nanomaterials chemistry
Christine Hrenya	Associate Professor	gas-solid flows, particle technology
Dhinakar Kompala	Associate Professor	biotechnology
Bev Louie	Senior Instructor	Director, Women in Engineering Program
Melissa Mahoney	Assistant Professor	drug delivery, tissue engineering
Will Medlin	Assistant Professor	surface chemistry, heterogeneous catalysis
Rich Noble	Look Professor	chemical separations, membranes
Fred Ramirez	Professor	process control, optimization
Ted Randolph	Gillespie Professor	biotechnology, supercritical fluids
Robert Sani	Professor	applied mathematics, fluid dynamics
Dan Schwartz	Professor	interfacial phenomena, complex fluids
Jeff Stansbury	Professor	dental/medical polymer materials, photopolymerization processes
Alan Weimer	Professor	ceramics, fluid-particle systems

\* = Chair (on sabbatical), # = Acting Chair, \*\* = Dean of the College of Engineering and Applied Science, ## = Associate Chair

## 11. Institutional Factors

### *a. Contribution to Department and Campus Diversity*

The CBEN Department faculty currently includes six women, but no underrepresented minorities. Faculty searches have led to the hiring of two female faculty in the biological engineering area in the past year.

Increasing the enrollment and retention of minorities and women in our department is an essential component of our department's mission. Chemical Engineering at CU already does an excellent job of attracting women to the department. Currently, our undergraduates include 34% women, double the College of Engineering value at 17%, while there are 7.9% under-represented minority students (Hispanic, Black and Native American), slightly greater than the College value of 7.4%. However, we would like these numbers to be more representative of the population in general, and our goal is to increase these percentages to at least 40% women and 15% underrepresented minority students. As part of our focus on recruiting and retaining underserved populations in undergraduate engineering, we will be actively involved with programs that focus on minorities and women. In particular, we will be involved with the Multicultural Engineering Program (MEP), an academic excellence community dedicated to the success of multicultural and first generation students historically underrepresented in engineering and applied science, and Women in Engineering Program (WIEP), whose mission is to foster the success of women in engineering by recruiting, retaining, and encouraging women engineering students, to supplement many of their ongoing activities with biological engineering.

The existence of a Cooperative Education Program as a means of helping to pay for school will improve the attractiveness of our program as will the NIH/HHMI Scholars Program for Diversity in the Biosciences, an academic excellence program that supports undergraduate students historically underserved in bioscience fields. The program consists of laboratory training, beginning and advanced research, seminars, summer research opportunities, and both professional development and graduate school

preparation activities. The program has committed to hire and train suitable chemical and biological engineering students, which we will then place in appropriate laboratories.

#### ***b. Effect on Other Programs***

Freshman and sophomore level core courses have recently been developed for the Chemical and Biological Engineering program aimed to serve all engineering students in the College of Engineering and Applied Science. *Biology for Engineers* (freshman level course, currently taught every year as special topics; applying for course number) offers students an opportunity to take a biology course taught by engineers that provides a broad background in the appropriate basics, but also motivates students with respect to current research in the field. Additionally, once there is sufficient industrial interest, this course will be offered at a time when local industrial scientists and engineers can enroll and take the course. Currently the course is offered every Spring semester, and the current enrollment is primarily Chemical Engineering Undergraduates; however, a few students of other majors have been taking the course (in Spring 2005, 4 of 68 students were not Chemical Engineering majors). *Foundations of Bioengineering* (piloted Fall 2005, proposed 2000-level course) will subsequently provide the initial technical platform from which students can pursue upper-level courses in bio-based degree programs or options within the existing infrastructure of the College of Engineering and Applied Science.

#### ***c. Effect on Existing Resources***

No effect is expected on the library. Chemical and Biological Engineering currently operates the Borgmann Computer Laboratory, in addition to other ITS computer facilities, to provide additional computer resources for students.

#### ***d. Formal Affiliations***

The Chemical and Biological Engineering degree program is expected to have a Cooperative Education Program, building on the existing program in Chemical Engineering that alternates academic semesters with co-op work semesters to provide students with real professional experience while completing the course requirements for the Chemical Engineering undergraduate degree. This program has proven to be very popular with students, with more students wanting internships than are available. This is especially true in biological engineering, where many of the prospective companies are too small to commit to having a student for three semesters. Therefore, it is proposed to have a consortium of these small companies where co-op students can rotate through three different ones. Local companies include Amgen, Roche, Ribozyme Pharmaceuticals, Replidyne, Array BioPharma, Somalogic, Gambro, Geneva Pharmaceuticals and Atrix, some of which have already established a relationship with our department.

### **12. Physical Capacity and Needs**

#### ***a. Space Estimates (Table 2)***

Current classroom, office and study space in the Engineering Center Building used by the Chemical and Biological Engineering Department is sufficient for the new program. Additional instructional laboratory space is required.

### ***b. Description of Space Estimates***

The additional space needed for the Chemical and Biological Engineering degree program relates to an increase in the undergraduate laboratory facility for Chemical and Biological Engineering. Currently, the department has a 2000 square foot teaching laboratory with an adjoining classroom. Facilities in the College of Engineering and Applied Science's Integrated Teaching and Learning Laboratory (ITLL) facility are utilized for CHEN 3130, Chemical Engineering Laboratory 1, and would continue to serve this role. Approximately 750 square feet of new laboratory space is needed for the proposed biological section of CHEN 4830: CBEN Laboratory 2. The space needs to include room for biological engineering equipment and its associated usage (i.e. benchtop preparation area and consumables storage). Two sections of CHEN 4830, with no more than 25 students per section, would be needed to teach the course initially. Thus classes would be meeting in this laboratory space approximately 8 hours per week, with the number of sections and hours of laboratory use growing if necessary with enrollment in the degree program. The space would be shared with the Foundations of Bioengineering Laboratory (2XXX), when it is developed.

Projected biological equipment needs include two tissue culture hoods, an incubator and shaker, centrifuges, microscopes, a plate reader, a lyophilizer, electrophoresis equipment, pipetters, bioreactors, two spectrophotometers (already received via donation), two HPLCs and a fluorimeter. Consumables associated with the biological laboratory and included in operating expenses include pipet tips, centrifuge tubes, HPLC columns, gels, media, and reagents.

CHEN 4830: CBEN Laboratory 2 would not be required until the first senior class of the proposed degree, allowing a couple years of preparation. The course will initially be piloted within the existing, 2000 square foot teaching laboratory for CHEN 4130: Chemical Engineering Laboratory 2. As enrollments in the new degree program grow to their expected size, the addition of about 750 square feet would be required. The current plan is to use the biological teaching laboratory that is being planned as a part of CU-Boulder's new biotechnology building. The feasibility study for this building has been approved and the program plan is currently under development, including a timeline with occupancy in August 2009. If the biotechnology building is substantially delayed (i.e., beyond five years from now), and the enrollments in the new degree program become sufficiently large, then reassignment and renovation of existing space will be made within the current Engineering Center.

## **13. Cost Description and Source of Funds**

### ***a. Cost Estimates (Table 3)***

The cost estimates in Table 3 were generated with the following assumptions:

- At full implementation (year 3), six new required courses will need to be taught. Four of the six courses are currently taught every other year, as elective courses (Foundations of Bioengineering, Bioseparations, Bioprocess Engineering, and Biomaterials). Each course currently taught every other year, will be an increase of half a course in the new program. The other two courses (Biokinetics and Chemical and Biological Engineering Laboratory 2) would be new courses. The net result is an increase in teaching load of 4 courses per year. To help meet

this need, the Department of Chemical and Biological Engineering intends to hire a full-time instructor, who will spend approximately half time on the teaching/advising/service for the new degree program (with the other half time on the existing degree program). As discussed in the narrative of Table 3, a continuing budget request will be made to campus starting in FY09 for one-half of this position (\$40,000 salary plus benefits), if warranted by enrollment growth from new tuition revenue.

- Also included is the cost of one graduate student teaching assistant for each of the 4 new courses per year (phased in). The cost of the teaching assistant is their monthly stipend (currently \$1,895.33 per month) plus tuition and benefits. All students are assumed to be out-of-state for purposes of tuition payment, as primarily first-year, nonresident graduate students serve as teaching assistants in the CBEN Department. As discussed in the narrative of Table 3, a continuing budget request will be made to campus starting in FY09 for two teaching assistants per year (about \$80,000 stipend and tuition for nonresidents, or \$45,000 if the plan to use resident tuition rates is implemented for graduate students on appointment) from new tuition revenue, if warranted by enrollment growth.
- Administrative support for the program will include laboratory and clerical support. It includes a combination of 3% of an electrical engineer, 5% of a facilities and personnel support person, 3% of the department manager, and 3% of a student support administrative assistant. This support is expected to come from existing college resources via the college budget formula based on numbers of majors and student credit hours taught.
- Laboratory operating expenses include consumables, such as pipette tips, centrifuge tubes, HPLC columns, gels, media, and reagents. The estimate for operating expenses includes both CHEN 4830 and a Foundations of Bioengineering Laboratory. Funds will be provided from course fees and the college budget formula.
- Capital construction costs assume \$300 per square foot to renovate 750 square feet of laboratory space. This support will be required only if the new biotechnology building is not ready within five years and would come from college renovation funds and leveraged matching.
- Equipment acquisitions include all equipment needed to operate both the CBEN Laboratory 2 and the Foundations of Bioengineering Laboratory. Sources of funds (see Table 3) include the Engineering Excellence Fund, college/campus investment management funds, and industry donations. Equipment to be acquired and its estimated cost is as follows:

<u>Qty</u>	<u>Equipment</u>	<u>Estim. Cost/Each</u>	<u>Total Cost</u>
1	Autoclave	\$ 30,000	\$ 30,000
2	Tissue Culture Hoods	\$ 10,000	\$ 20,000
1	Incubator	\$ 7,000	\$ 7,000
3	Centrifuges-2 mini, 1 Eppendorf	\$ 7,500	\$ 22,500
2	Basic Microscopes	\$ 7,000	\$ 14,000
1	Microscope	\$ 50,000	\$ 50,000
1	Plate Reader	\$ 30,000	\$ 30,000
1	Lyophilizer	\$ 70,000	\$ 70,000
4	Electrophoresis Setup	\$ 500	\$ 2,000
2	Fermentors/Bioreactors	\$ 25,000	\$ 50,000

5	Pipetter sets	\$	1,000	\$ 5,000
2	UV-Vis Spectrophotometers	\$	11,000	\$ 22,000
1	Shaker	\$	7,000	\$ 7,000
2	HPLC (UV-Vis Detectors)	\$	50,000	\$100,000
1	Fluorimeter	\$	10,000	\$ 10,000
Total of all Equipment				\$439,500

## 14. Other Relevant Information

### a. Course Descriptions

Potential catalog descriptions are included for four courses currently taught as special topics courses that would become required courses for students in the Chemical and Biological Engineering degree program.

#### CHEN 2810: Biology for Engineers

Develops a basic understanding of the science of biology, including an introduction to the disciplines of biochemistry, cell organization, metabolism, genetics, genomics, molecular biology, recombinant DNA technology and evolution. Provides a basic introduction to several key techniques used in biological engineering laboratories. Uses examples of complex and creative structures engineered by natural processes.

#### CHEN 2XXX: Foundations of Bioengineering

Provides an introduction to the fundamental science and engineering principles on which bioengineering is based. Topics will include a study of: the structure/function of biomolecules, cell communication, nutrient supply, metabolism, and excretion, fluid flow in the circulatory system, bioinstrumentation, drug delivery, and tissue engineering. In addition, students will be introduced to important professional, societal, and entrepreneurial issues in the field by examining case studies in which drugs and medical products have been developed and FDA approved for clinical use.

#### CHEN 4XXX: Pharmaceutical Biotechnology

Incorporates biochemistry, pharmaceutical science, and engineering for application in the pharmaceutical industry.

#### CHEN 4XXX: Biomaterials

Provides an overview of the field of biomaterials. Covers major classes of materials used in medical applications; characterization methods, properties and degradation mechanisms for biomaterials; foreign body response to biomaterials; methods to control physiological response to biomaterial surfaces; biocompatibility; biomaterials used in soft and hard tissue replacements, drug delivery devices and tissue engineering; and design criteria for developing a material for a given biological application.

## TABLE 1: ENROLLMENT PROJECTIONS

Name of Program: B.S. in Chemical and Biological Engineering

Name of Institution: University of Colorado at Boulder

### DEFINITIONS:

Academic year is the period beginning July 1 and concluding June 30.

Headcount projections represent an unduplicated count of those students officially admitted to the program and enrolled at the institution during the academic year.

FTE is defined as the full-time equivalent number of those students majoring in the program, regardless of the classes enrolled, during the academic year.

Program graduate is defined as a student who finishes all academic program requirements and graduates with a formal award within a particular academic year.

### SPECIAL NOTES:

To calculate the annual headcount enrollment, add new enrollees to the previous year headcount and subtract the number who graduated in the preceding year. Adjust by the anticipated attrition rate.

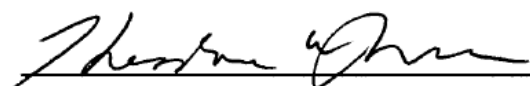
To calculate FTE, multiply the number of students times the projected number of credit hours students will be typically enrolled in per year and divide by 30.

The data in each column is the annual **unduplicated** number of declared program majors. Since this table documents program demand, course enrollments are not relevant and shall not be included in the headcount or FTE data.

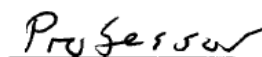
		Yr 1 06-07	Yr 2 07-08	Yr 3 08-09	Yr 4 09-10	Yr 5 10-11	Full Implementation
1-a	In-state Headcount	42	61	85	90	104	104
1-b	Out-of-State Headcount	8	13	17	19	21	21
2	Program Headcount	50	74	102	109	125	125
3-a	In-state FTE	44	67	90	96	111	111
3-b	Out-of-state FTE	9	14	19	20	23	23
4	Program FTE	53	81	109	116	134	134
5	Program Graduates	0	0	25	20	24	30

Attach a brief description explaining the specific source data for projecting the program headcount (e.g., actual enrollment in a similar program at a comparable college).

Table 1 projections were formulated based on the following: Students are following the standard curriculum with FTEs based on 30 semester credit hours during freshman and senior years and 34 semester credit hours the sophomore and junior years; the average time to complete the B.S. degree is 4 years; the average percentage of in-state students in the Chemical and Biological Engineering Department over the past 6 years of 83% has been used; and student retention from freshman to sophomore year is 82% (the average retention rate in Chemical Engineering students over the past five years). The overall average retention rate in Chemical Engineering over the past five years from freshman year through senior year is only slightly lower than the retention rate from freshman to sophomore year, and has been neglected in this table. The first year headcount assumes that one-third of the current freshman class would transfer to the new degree program as sophomores, and an additional one-third of a similar-sized entering class would also join the program as freshman. The freshman class is expected to increase by 15% per year for each of the first five years of the program.



Signature of Person who completed the Enrollment Table



Title

## TABLE 2 : PHYSICAL CAPACITY ESTIMATES

Name of Program: B.S. in Chemical and Biological Engineering

Name of Institution: University of Colorado at Boulder

Purpose: This table documents the physical capacity of the institution to offer the program and/or the plan for achieving the capacity. Complete A or B.

---

### Part A

I certify that this proposed degree program can be fully implemented and accommodate the enrollment projections provided in this proposal without requiring additional space or renovating existing space during the first five years.



\_\_\_\_\_  
Campus Capital Construction Officer

2/3/06

\_\_\_\_\_  
Date

### Part B

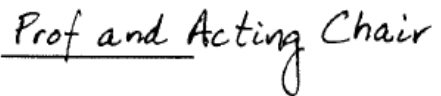
	Column 1	Column 2	Column 3		Column 4		Column 5	Column 6
ASSIGNABLE SQUARE FEET	TOTAL NEEDED	AVAILABL E	RENOVATION		NEW CONSTRUCTION		LEASE/ RENT	REVENUE SOURCE*
TYPE OF SPACE			Immed.	Future	Immed.	Future		
Classroom								
Instructional Lab	2750	2000		750				
Offices								
Study								
Special/General Use								
Other:								
<b>TOTAL</b>	<b>2750</b>	<b>2000</b>		<b>750</b>				

\* Capital Construction Fund (CCF), Research Building Revolving Fund (RBRF), Gift (GIFT), Grant (GR), Auxiliary Fund (AUX)

Attach a narrative describing the institutional contingency plan that addresses the space requirements of the proposed program or alternative delivery options, in the event that the request for capital construction or renovation is not approved.



Signature of Person who completed the Institutional Physical Capacity Table



Title

### TABLE 3: PROJECTED NEW EXPENSES FOR NEW PROGRAM

(Do not include an inflation factor when projecting over 5 years)

#### I. Expenses and Revenues

Below, list all new expenses that will be incurred over the first five years (by year) of the new program, broken into the categories provided. Following the table, provide a narrative that, for each category of expense, identifies the source of funds that will cover these expenses: tuition, COF or fee-for-service funds, clinical income, and endowment, gift, grant or contract funds.

If expenses are to be covered by reallocation of existing resources, specify what activities and costs will be discontinued and how existing resources/responsibilities will be reallocated. Be quite specific.

Will any new cash revenue be generated by this new program? How much and from what sources?

		ESTIMATED AMOUNT in DOLLARS				
		YEAR 1 2006-07	YEAR 2 2007-08	YEAR 3 2008-09	YEAR 4 2009-10	YEAR 5 2010-11
Operating Expenses						
1	Faculty	\$10,000	\$20,000	\$40,000	\$40,000	\$40,000
2	Teaching Assistants	\$19,932	\$39,864	\$79,728	\$79,728	\$79,728
3	Financial Aid specific to program	\$0	\$0	\$0	\$0	\$0
4	Instructional Materials	\$0	\$0	\$0	\$0	\$0
5	Program Administration	\$3,197	\$3,197	\$7,307	\$7,307	\$7,307
6	Rent/Lease	\$0	\$0	\$0	\$0	\$0
7	Laboratory & Other Operating Costs	\$0	\$0	\$15,000	\$15,000	\$15,000
8	Total Operating Expenses	\$33,129	\$63,061	\$142,035	\$142,035	\$142,035

Program Start-Up Expenses						
9	Capital construction	\$0	\$0	\$0	\$0	\$225,000
10	Equipment Acquisitions	\$112,000	\$81,875	\$81,875	\$81,875	\$81,875
11	Library Acquisitions	\$0	\$0	\$0	\$0	\$0
12	Total Program Start-Up Exp.	\$112,000	\$81,875	\$81,875	\$81,875	\$306,875
<b>TOTAL PROGRAM EXPENSES</b>		<b>\$145,129</b>	<b>\$144,936</b>	<b>\$223,910</b>	<b>\$223,910</b>	<b>\$448,910</b>
Program Revenue						
13	Tuition	\$27,166	\$51,710	\$111,647	\$111,844	\$111,057
14	College Opportunity Fund	\$5,963	\$11,351	\$24,508	\$24,551	\$24,378
15	Course Fees	\$0	\$0	\$5,880	\$5,640	\$6,600
16	Corporate Grants/Donations	\$22,000	\$49,438	\$49,438	\$49,438	\$49,438
17	Engineering Excellence Fund and Investment Management Funds	\$90,000	\$32,437	\$32,437	\$32,437	\$32,437
18	College Renovation Fund	\$0	\$0	\$0	\$0	\$225,000
<b>TOTAL PROGRAM REVENUE</b>		<b>\$145,129</b>	<b>\$144,936</b>	<b>\$223,910</b>	<b>\$223,910</b>	<b>\$448,910</b>

## ***II. Narrative Explaining How Costs are to be Covered***

The 104 in-state students and 21 out-of-state students at full implementation are expected to provide \$1,096,020 in annual tuition revenue (based on AY 05-06 rates), plus \$249,600 in College Opportunity Funds. While taking into account that many of these students would be reallocations from other majors, as opposed to new students who come to CU only because of the new major – and that a substantial portion of tuition and other general funds is spent at the college, campus, and system levels, it is expected that the new, net revenue will be more than sufficient to cover the annual operating expenses. More specifically, the College of Engineering and Applied Science has a formula-based budget allocation to departments for part-time instructors, teaching assistants, support staff, operating expenses, and laboratory equipment, which is based on the student-credit-hour generation by each department. This formula, together existing department resources and new course fees for the new laboratory courses, will cover the costs of offering the degree program during its startup phase. Starting in FY09, the instructor support (about \$40,000 per year) and teaching assistant support (about \$80,000 per year or \$45,000 per year under the new graduate tuition policy) will be requested as continuing budget from the campus assuming that the net growth in students to the department and college is large enough to provide sufficient tuition growth to campus. Otherwise, existing resources will be redistributed via the college budget formula to cover the program costs. The course fees are based on \$120 per student for CBEN Laboratory 2 and Foundations of Bioengineering Laboratory. The startup equipment acquisitions will be covered approximately one-half from corporate donations and one-half from proposals to the Engineering Excellence Fund and other college/campus programs, a funding model which has proven successful with the existing Chemical Engineering Laboratory. Indeed, the Year 1 funding of a \$22,000 corporate donation and \$90,000 campus/college investment management award are already in place. Finally, the laboratory capital renovation funds, if not covered as part of the new biotechnology building capital construction, will be provided through the College of Engineering and Applied Science's Laboratory Renovation Fund (which requires a one-third cost-share from the department and for which leveraging of campus investment management funds will be sought).

## ***III. Dean's Statement.***

Attach a statement from the Dean verifying Adequacy of Resources to Support New Program and confirming that the projected resources and reallocations are reasonable.

See cover letter provided by the Dean.

## **APPENDIX: Faculty Vitas**

Anseth, Kristi

Bowman, Christopher

Bryant, Stephanie

Clough, David

Davis, Robert

deGrazia, Janet

Falconer, John

George, Steven

Gill, Ryan

Gin, Doug

Hrenya, Christine

Kompala, Dhinakar

Louie, Beverly

Mahoney, Melissa

Medlin, J. William

Noble, Richard

Ramirez, Fred

Randolph, Theodore

Sani, Robert

Schwartz, Daniel

Weimer, Alan

## KRISTI S. ANSETH

Department of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 492-3147 or 2-3147  
Fax: (303) 735-0095  
email: kristi.anseth@colorado.edu  
website: <http://www.Colorado.EDU/che/ansethgroup>

### EDUCATION

Ph.D., Chemical Engineering, University of Colorado, 1994  
B.S., Chemical Engineering(with Highest Distinction), Purdue University, 1992

### PROFESSIONAL EXPERIENCE

Howard Hughes Medical Institute Assistant Investigator. Aug. 2000 to present  
Associate Faculty Director. Initiative in Molecular Biotechnology, University of Colorado, Boulder, Nov., 2003 to present  
Tisone Professor, Chemical and Biological Engineering, University of Colorado, Boulder, Sept. 2003 to present  
Professor (by courtesy). Chemistry and Biochemistry, University of Colorado, Boulder, March, 2004 to present  
Professor (by courtesy). Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, March, 2004 to present  
Professor. Chemical Engineering, University of Colorado, Boulder. Aug. 2002 to Aug. 2003  
Patten Associate Professor. Chemical Engineering, University of Colorado, Boulder. Aug. 1999 to July 2002  
Associate Professor. Surgery, University of Colorado Health Sciences Center, Denver. Aug. 2000 to present  
Patten Assistant Professor. Chemical Engineering, University of Colorado, Boulder. Sept. 1998 to July 1999  
Assistant Professor. Chemical Engineering, University of Colorado, Boulder. Aug. 1996 to Aug. 1998  
Research Fellow. Dr. Robert Langer, mentor. MIT, Cambridge, MA. Sept. 1995 to July 1996

### CONSULTING, PATENTS

Five (5) issued U.S. Patents; five (5) pending U.S. Patents; co-founded Cartilix and CLD  
Microtechnologies Consulting: Abbott, Gambro, Bropland, DuPont, Sonatech, Sulzer, Stryker, Johnson & Johnson

### SELECTED PUBLICATIONS OF 100 IN LAST FIVE YEARS

K.S. Masters, D.N. Shah, L.A. Leinwand, and **K.S. Anseth**, "Crosslinked Hyaluronan Scaffolds as a Biologically Active Carrier for Valvular Interstitial Cells," *Biomaterials*, 26, 2517-25 (2005).  
C.R. Nuttelman, M.C. Tripodi, and **K.S. Anseth**, "In Vitro Osteogenic Differentiation of Human Mesenchymal Stem Cells Photoencapsulated in PEG Hydrogels," *Journal of Biomedical Materials Research*, 68A(4), 773-82 (2004).  
S.J. Bryant and **K.S. Anseth**, "Controlling the Spatial Distribution of ECM Components in Degradable PEG Hydrogels for Tissue Engineering Cartilage," *Journal of Biomedical Materials Research*, 64A, 70-79 (2003).  
J.A. Burdick, M.N. Mason, A.D. Hinman, K. Thorne, and **K.S. Anseth**, "Delivery of Osteoinductive Growth Factors from Degradable PEG Hydrogels Influences Osteoblast Differentiation and Mineralization," *Journal of Controlled Release*, 83, 53-63 (2002).  
M. N. Mason, A.T. Metters, C.N. Bowman and **K.S. Anseth**, "Predicting Controlled-Release Behavior of Degradable PLA-b-PEG-b-PLA Hydrogels," *Macromolecules*, 34, 4630-35 (2001).

### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, American Chemical Society, Materials Research Society, Controlled Release Society, Society for Biomaterials, Society for Biological Engineering, Biomedical Engineering Society

### HONORS AND AWARDS

2005 Alan S. Michaels Distinguished Lecture in Medical and Biological Engineering at MIT  
2004 Alan T. Waterman Award, National Science Foundation  
2004 Boulder Faculty Assembly Excellence in Research, Scholarly and Creative Work Award  
2004 Kalpana Chawla Outstanding Recent Alumni Award, University of Colorado  
2003 Allan P. Colburn Award, American Institute of Chemical Engineers  
2003 Curtis W. McGraw Award, American Society for Engineering Education  
2002 Hutchinson Teaching Award, College of Engineering and Applied Science  
2001 American Institute for Medical and Biological Engineering, Fellow  
2001 Materials Research Society, Outstanding Young Investigator Award  
2000 Camille Dreyfus Teacher-Scholar Award  
2000 Outstanding Graduate Advising Award, University of Colorado Graduate School  
2000 Boulder Faculty Assembly Teaching Excellence Award  
1999 Dow Outstanding New Faculty Award, American Society for Engineering Education  
1998-2003 FIRST Award, National Institutes of Health  
1998-2002 CAREER Award, National Science Foundation  
1998-2000 3M Faculty Award  
1998 John and Mercedes Peebles Teaching Innovation Award, College of Engineering  
1997-1998 Outstanding Graduate Teacher Award, Department of Chemical Engineering  
1997-2002 David and Lucile Packard Fellowship for Science and Engineering  
1998-2001 DuPont Young Professor Grant  
1996-2001 Camille and Henry Dreyfus New Faculty Award

### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Board of reviewing editors, Science  
Editorial board, Biotechnology & Bioengineering  
Editorial board, Acta Biomaterialia  
Voting Member, FDA Dental Products Panel  
Member, NIH, NIBIB Musculoskeletal Study Section  
Organized and Chaired 15 meeting symposium  
Served on 17 different NIH or NSF proposal review panels  
Reviewer of manuscripts (24/year)  
Technical Operating Council, AIChE  
Board of Directors, Materials Research Society  
Societal Alliance Committee and Awards Committee, Society for Biomaterials  
Advisory Council, Society for Biological Engineering  
External Review Committee, MIT Soldier Nanotechnology Initiative  
co-Director of two GAANN programs in Biological Engineering and Functional Materials  
Associate Faculty Director, University of Colorado Molecular Biotechnology Initiative  
Biological Engineering Committee Chair (F03-S04) and Member (present)  
Admissions and Executive Committee Member for the Medical Scientist Training Program (MD/PhD program)  
CU Roadshow Faculty Participant on the National Council Tours  
Advisor of undergraduate students in the Materials and Bio-options

### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

Attend numerous national and international meetings  
(presenting/attending research & educational sessions) annually

## CHRISTOPHER N. BOWMAN, PROFESSOR

Department Chair and Gillespie Faculty Fellow  
Department of Chemical and Biological Engineering  
University of Colorado, Boulder, CO 80309-0424  
Phone: (303) 492-3247, Fax: (303) 492-4341  
Email: [christopher.bowman@colorado.edu](mailto:christopher.bowman@colorado.edu)  
website: <http://www.colorado.edu/che/faculty/bowman.html>

### EDUCATION

Ph.D., Chemical Engineering, Purdue University, 1991  
B.S., Chemical Engineering (with Honors), Purdue University, 1988

### PROFESSIONAL EXPERIENCE

Assistant Professor, Chemical Engineering, University of Colorado, 1/92 – 8/95  
Associate Professor, Chemical Engineering, University of Colorado, 8/95 – 8/99  
Professor and Gillespie Faculty Fellow, Chemical and Biological Engineering, University of Colorado, 8/99 – present  
Co-Director, Industry/University Cooperative Research Center for Fundamentals and Applications of Photopolymerizations, 1/2000 – present  
Clinical Professor of Dentistry, University of Colorado, Health Sciences Center, 1/01 – present  
Department Chair, Chemical and Biological Engineering, 8/2003 – present

### CONSULTING, PATENTS

1 Issued U.S. Patent, 12 pending (filed) U.S. Patents

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

1. H.M. Simms, C.M. Brotherton, B.T. Good, R.H. Davis, K.S. Anseth, and C.N. Bowman, "In Situ Fabrication of Macroporous Polymer Networks within Microfluidic Devices by Living Radical Photopolymerization and Leaching," *Lab on a Chip*, 5, 151-157 (2005).
2. H. Lu, J.W. Stansbury, J. Nie, K. Berchtold, and C.N. Bowman, "Development of Highly-reactive Mono-(meth)acrylates as Reactive Diluents for Dimethacrylate Based Dental Resin Systems," *Biomaterials*, 26, 1329 (2005).
3. J.B. Hutchison, K.T. Haraldsson, B.T. Good, R.P. Sebra, N. Luo, K.S. Anseth, and C.N. Bowman, "Robust Polymer Microfluidic Device Fabrication Via Contact Liquid Photolithographic Polymerization (CLiPP)," *Lab on a Chip* 4, 658-662 (2004).
4. H. Lu, J.W. Stansbury, and C.N. Bowman, "Towards the Elucidation of Shrinkage Stress Development & Relaxation in Dental Composites," *Dental Materials* 20, 979 (2004).
5. H. Lu, J.W. Stansbury, S.H. Dickens, F.C. Eichmiller, and C.N. Bowman, "Probing the Origins and Control of Shrinkage Stress in Dental-Resin Composites: I. Shrinkage Stress Characterization Technique," *Journal of Materials Science: Materials in Medicine* 15, 1097 (2004).
6. H. Lu, J.W. Stansbury, S.H. Dickens, F.C. Eichmiller, and C.N. Bowman, "Probing the Origins and Control of Shrinkage Stress in Dental-Resin Composites: II. Novel Method of Simultaneous Measurement of Polymerization Shrinkage Stress and Conversion," *Journal for Biomedical Materials Research Part B: Applied Biomaterials* 71B, 206 (2004).
7. N.B. Cramer, S.K. Reddy, M. Cole, C. Hoyle, and C.N. Bowman, "Initiation Mechanisms in Thiol-Ene Photopolymerizations without Photoinitiators," *Journal of Polymer Science, Part A: Polymer Chemistry* 42, 5817 (2004).
8. B.T. Good, C.N. Bowman, and R.H. Davis, "Modeling and Verification of Fluid-Responsive Polymer Pumps for Microfluidic Systems," *Chemical Engineering Science*, 59 5967 (2004).
9. E.R. Beckel, J. Nie, J.W. Stansbury, and C.N. Bowman, "Effect of Aryl Substituents on the Reactivity of Phenyl Carbamate Acrylate Monomers," *Macromolecules*, 37, 4062 (2004).

10. K.A. Berchtold, J. Nie, J.W. Stansbury, B. Hacıoglu, E.R. Beckel, and C.N. Bowman, "Novel Monovinyl Methacrylic Monomers Containing Secondary Functionality for Ultrarapid Polymerization: Steady State Evaluation," *Macromolecules*, 37, 3165 (2004).
11. P.J. Martens, C.N. Bowman, and K.S. Anseth, "Degradable Networks Formed from Multifunctional Poly(Vinyl Alcohol) Macromers: Experimental Validation of a Generalized Bulk-Degradation Model for Polymer Networks," *Polymer*, 45, 3377 (2004).
12. N.B. Cramer, S.K. Reddy, H. Lui, R. Raj, and C.N. Bowman, "Thiol-Ene Photopolymerization of Polymer Derived Ceramic Precursors," *Journal of Polymer Science, Part A: Polymer Chemistry*, 42, 1752 (2004).
13. J. Elliott, M. Macdonald, J. Nie, and C.N. Bowman, "Structure and Swelling of Poly(Acrylic) Hydrogels: Effect of pH, Ionic Strength, and Dilution on the Crosslinked Polymer Structure," *Polymer*, 45, 1503 (2004).

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

AIChE, ACS, ASEE, IADR, AIMBE

#### HONORS AND AWARDS

Clemson University Award for Contributions to the Biomaterials Literature, 2005  
 College of Engineering Max S. Peters Outstanding Service Award, 2004  
 University of Colorado Technology Transfer Office Physical Sciences Inventor of the Year, 2003  
 College of Engineering John and Mercedes Peebles Teaching Innovation Award, 2002  
 Boulder Faculty Assembly Award for Excellence in Research, Scholarly, and Creative Work, 2002  
 Department of Chemical Engineering Outstanding Undergraduate Teaching Award, 2002  
 American Institute of Chemical Engineers Allan P. Colburn Award, 2001  
 American Society of Engineering Education Curtis W. McGraw Award, 2000  
 Fellow, American Institute of Medical and Biological Engineers, 1999  
 Alfred P. Sloan Research Fellow, 1998 - 2000  
 Materials Research Society Outstanding Young Investigator Award, 1997  
 Camille Dreyfus Teacher-Scholar Award, 1996  
 University of Colorado Outstanding Faculty Graduate Advisor, 1995  
 National Science Foundation Presidential Faculty Fellowship, 1994 - 1999  
 Department of Chemical Engineering Outstanding Graduate Teaching Award, 1994  
 ASEE Rocky Mountain Section Dow Outstanding New Faculty Award, 1994

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Department Chair (Fall 2003 – present); Editorial Board, *Journal of Macromolecular Science, Pure and Applied Chemistry*, Fall 2004–; Chair ACS Symposium on "Advances in Photopolymerizations" for ACS National Meeting, Fall 2004, Philadelphia, PA; Taught one day short course on "Photopolymerization Reactions" at Radtech National Meeting, May, 2004; Director, Materials Division of the American Institute of Chemical Engineers, November 2003 – present; Session Chair, "Dental Materials: Polymer Materials-Chemistry," International Association for Dental Research 82<sup>nd</sup> General Session, Honolulu, HI, March, 2004; Session Chair, "Polymer Networks," 26<sup>th</sup> Australasian Polymer Symposium, Noosa, Australia, July, 2003; Session Chair, "Dental Materials: V – Polymer Materials--Chemistry Program," International Association of Dental Research Annual Meeting, San Antonio, TX, March, 2003; Chair, workshop and summer school on Free Radical Polymerization Methods, 25<sup>th</sup> Australasian Polymer Symposium, Armidale, Australia, February, 2002; Committee Chair, "Biomedical and Chemical Engineering Panel," 2001 NSF Graduate Research Fellowship Panel, February, 2001; Program co-Chair, Division of Polymer Chemistry, Fall 2000 – Fall 2003; Editorial Board, *Polymer Reaction Engineering*, January 1997 – present

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

Attend numerous national and international meetings (presenting/attending research and educational sessions) annually; Developed three new courses

## STEPHANIE J. BRYANT, ASSISTANT PROFESSOR

Department of Chemical and Biological Engineering

University of Colorado

Boulder, CO 80309-0424

Phone: (303) 735-6714

Fax: (303) 492-4341

email: [stephanie.bryant@colorado.edu](mailto:stephanie.bryant@colorado.edu)

### EDUCATION

Ph.D., Chemical Engineering, University of Colorado, 2002

B.S., Chemical Engineering, University of Texas, 1995

### PROFESSIONAL EXPERIENCE

Assistant Professor, University of Colorado, Boulder, CO (2005-)

Post-doctoral Research Position, University of Washington, Seattle, WA (2003-2005)

### PATENTS

1 pending (filed February 24, 2005) U.S. Patents, 'Methods for Photopatterning Hydrogels'

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- (1) S.J. Bryant, C.R. Nuttelman and K.S. Anseth. Cytocompatibility of Ultraviolet and Visible Light Photoinitiating Systems on Cultured NIH/3T3 Fibroblasts *In Vitro. Journal of Biomaterials Science. Polymer Edition.* 11(5): 439-457 (2000)
- (2) S.J. Bryant and K.S. Anseth. The effects of scaffold thickness on tissue engineered cartilage in photocrosslinked poly(ethylene oxide) hydrogels. *Biomaterials.* 22: 619-626 (2001)
- (3) S.J. Bryant and K.S. Anseth. Hydrogel properties influence ECM production by chondrocytes photoencapsulated in poly(ethylene glycol) hydrogels. *Journal of Biomedical Materials Research.* 59: 63-72 (2001)
- (4) K.S. Anseth, A.T. Metters, S.J. Bryant, P.J. Martens, J.H. Elisseeff, C.N. Bowman. *In situ* forming degradable networks and their application in tissue engineering and drug delivery. *Journal of Controlled Release.* 78:199-209 (2001)
- (5) S.J. Bryant and K.S. Anseth. Controlling the spatial distribution of ECM components in degradable PEG hydrogels for tissue engineering cartilage. *Journal of Biomedical Materials Research.* 64A(1):70-79(2003)
- (6) P.J. Martens, S.J. Bryant, and K.S. Anseth. Tailoring the degradation of hydrogels formed from multivinyl poly(ethylene glycol) and poly(vinyl alcohol) macromers for cartilage tissue engineering. *Biomacromolecules.* 4(2): 283-292 (2003)
- (7) S.J. Bryant, K.L. Durand, and K.S. Anseth. Manipulations in hydrogel chemistry control photoencapsulated chondrocyte behavior and their extracellular matrix production. *Journal of Biomedical Materials Research.* 67A: 1430-1436 (2003)
- (8) S.J. Bryant, R.J. Bender, K.L. Durand, and K.S. Anseth. Encapsulating chondrocytes in degrading PEG hydrogels with high modulus: engineering gel structural changes to facilitate cartilaginous tissue production. *Biotechnology and Bioengineering.* 86(7): 747-755 (2004)
- (9) S.J. Bryant, K.S. Anseth, D.A. Lee, and D.L. Bader. Crosslinking density influences the morphology of chondrocytes photoencapsulated in PEG hydrogels during the

- application of compressive strain. *Journal of Orthopaedic Research*. 22(5): 1143-1149 (2004)
- (10) S.J. Bryant, K.S. Anseth, T.T. Chowdhury, D.A. Lee, and D.L. Bader. Crosslinking density influences chondrocyte metabolism in dynamically loaded photocrosslinked poly(ethylene glycol) hydrogels. *Annals of Biomedical Engineering*. 32(3):407-417(2004)
- (11) S.J. Bryant, K.A. Davis-Arehart, N. Luo, R.K. Shoemaker and K.S. Anseth. Synthesis and characterization of photopolymerized multifunctional hydrogels: water-soluble poly(vinyl alcohol) and chondroitin sulfate macromers for chondrocyte encapsulation. *Macromolecules*. 37(18): 6726-6733 (2004)
- (12) B.D. Ratner and S.J. Bryant. Biomaterials: Where we've been and where we are going. *Annual Review of Biomedical Engineering*. Vol. 6: 41-75 (2004)
- (13) S.J. Bryant, J.A. Arthur, K.S. Anseth. Incorporation of tissue-specific molecules alters chondrocyte metabolism and gene expression in photocrosslinked hydrogels. *Acta Biomaterialia*. 1(2): 243-252 (2005)
- (14) S.J. Bryant and K.S. Anseth. Photopolymerization of Hydrogel Scaffolds *In Scaffolding in Tissue Engineering*. P.X. Ma and J. Elisseeff (editors). In press

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, Society of Biomaterials, Biomedical Engineering Society, Materials Research Society

#### HONORS AND AWARDS

2005 NIH/NIDCR K22 Career transition award, University of Colorado  
2003 NIH Individual NRSA post-doctoral fellowship, University of Washington  
1999 NSF Graduate Fellowship, University of Colorado  
1998 DoEd's Graduate Assistantships in Areas of National Need, University of Colorado

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

2005 Mentored Broomfield Highschool student in the research laboratory.  
2005 Attended Department of Education, GAANN retreat for graduate students  
2005 Undergraduate advising, Juniors, 25 students  
2005 Engineering Open House, Chemical and Biological Engineering Talk  
2005 Mentored HHMI/NIH Scholar, Undergraduate Researcher in the research laboratory  
2005 Member of PhD committee for Chelsea Collins and Laney Weber in Chemical and Biological Engineering

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

2005 Attended Teaching Excellence Workshop hosted by the College of Engineering

**David E. Clough, Professor**

Department of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 735-6714  
Fax: (303) 492-6638  
email: [David.Clough@colorado.edu](mailto:David.Clough@colorado.edu)

**Education**

Ph.D., University of Colorado, 1975, Chemical Engineering  
M.S., University of Colorado, 1969, Chemical Engineering  
B.S., Case Institute of Technology, 1968, Chemical Engineering

**Professional Experience in Education**

30 years on the faculty of Chemical Engineering at the University of Colorado  
University of Colorado, 1992-1999, 2002-2005 Associate Chair, Department of  
Chemical Engineering  
University of Colorado, 1986-1992, Associate Dean for Academic Affairs, College of  
Engineering and Applied Science  
University of Colorado, 1987-present, Professor of Chemical Engineering  
University of Colorado, 1981-1987, Associate Professor of Chemical Engineering  
University of Colorado, 1975-1981, Assistant Professor of Chemical Engineering

**Other Professional Experience**

E. I. du Pont de Nemours & Co., 1969-1972, Engineering Service Division, Chemical  
Engineer

**Consulting, Patents, etc.**

American Institute of Chemical Engineers, Continuing Education, Spreadsheet Power  
for Chemical Engineering Calculations, 96 short courses since 1989.

**Professional Registrations**

None

**Principal Publications in last five years**

with Dahl, J. K., V. H. Barocas, and A.W. Weimer, "Intrinsic Kinetics for Rapid  
Decomposition of Methane in an Aerosol Flow Reactor," *International Journal of  
Hydrogen Energy*, 27, 377-386, 2001.

with E. M. Bergheim, "Adaptive Generalized Predictive Control," *Proceedings of  
ISA 2001 Annual Conference and Exposition of the Instrumentation, Systems and  
Automation Society*, Houston, TX, September 11, 2001.

with S. C. Chapra and G. S. Huvard, "A Change in Approach to Engineering  
Computing for Freshmen – Similar Directions at Three Dissimilar Institutions,"

Proceedings of the 2001 Annual Conference of the American Society for Engineering Education, Albuquerque, June, 2001.

“ChE’s Teaching Introductory Computing to ChE Students – A Modern Computing Course with Emphasis on Problem Solving and Programming,” Proceedings of the 2002 Annual Conference of the American Society for Engineering Education, Montreal, June, 2002.

“The Missing Link in Process Control Education – Incorporating PLC’s into the ChE’s Control Course,” Proceedings of the 2002 Annual Conference of the American Society for Engineering Education, Montreal, June, 2002.

“Toward A Kinder, Gentler ABET,” Proceedings of the 2004 Annual Conference of the American Society for Engineering Education, Salt Lake City, June, 2004.  
Selected as the outstanding paper from ASEE Zone IV in 2003.

### **Society Memberships**

American Institute of Chemical Engineers (AIChE)  
American Society for Engineering Education (ASEE)

### **Honors and Awards in last five years**

Excellence in Service Award, Boulder Faculty Assembly, University of Colorado,  
2005

### **Institutional and Professional Service in last five years**

University of Colorado  
Associate Chair of Chemical Engineering, 2002-2005  
Faculty Athletics Representative, 2005-

### **Professional Development Activities in the last five years**

Attendance at Annual Conferences of ASEE, both Rocky Mountain Section &  
National  
Attendance at National Meetings of AIChE

## ROBERT H. DAVIS, PROFESSOR

Department of Chemical and Biological Engineering  
University of Colorado, Boulder, CO 80309-0424

Phone: (303) 492-7314, Fax: (303) 492-4341, email: [robert.davis@colorado.edu](mailto:robert.davis@colorado.edu)

### EDUCATION

Ph.D., Chemical Engineering, Stanford University, 1982  
M.S., Chemical Engineering, Stanford University, 1979  
B.S., Chemical Engineering, University of California at Davis, 1978

### PROFESSIONAL EXPERIENCE

Dean, College of Engineering and Applied Science, University of Colorado, 2002-  
Chair of Chemical Engineering, University of Colorado, Boulder, 1992-2002  
Professor of Chemical and Biological Engineering, University of Colorado, Boulder,  
1992-  
Patten Professor, University of Colorado, 1997-  
Associate Professor of Chemical Engineering, University of Colorado, Boulder, 1988-92  
Assistant Professor of Chemical Engineering, University of Colorado, Boulder, 1983-88  
NATO Postdoctoral Fellow, University of Cambridge, England, 1982-83  
Summer Professional, Shell Development Co., Houston, Texas, Summers 1978, 1979  
Research Engineer, E.I. du Pont de Nemours, Edgemoor, Delaware, Summer 1977  
Research Engineer, Cordis-Dow Corporation, Concord, California, Summer 1976  
Research Technician, Dow Chemical Co., Walnut Creek, California, Summer, 1975

### PATENTS

Marble, H. A. and R. H. Davis, "Strategy for Production of RNA Using Immobilized  
Templates, U.S. Patent No. 5,700,667 (1997).

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS (selected from 45 in 2000-2004)

Brotherton, C. M. and R. H. Davis, "Electroosmotic Flow in Channels with Step  
Changes in Zeta Potential and Cross Section," *J. Colloid Interface Sci.* 270,  
242-246 (2004).  
Kantak, A. A. and R. H. Davis, "Oblique Collisions and Rebound of Spheres from a  
Wetted Surface," *J. Fluid Mech.* 509, 63-81 (2004).  
Good, B. T., C. N. Bowman, and R. H. Davis, "Modeling and Verification of Fluid-  
responsive Polymer Micropumps," *Chem. Eng. Sci.* 59, 5967-5974 (2004).  
Rother, M. A. and R. H. Davis, "A Simplified Model for Droplet Growth in Shear  
Flow," *AIChE J.* 49, 546-548 (2003).  
Staben, M., A. Z. Zinchenko, and R. H. Davis, "Motion of a Particle Between Two  
Parallel Plane Walls in Low-Reynolds-Number Poiseuille Flow," *Physics of  
Fluids* 15, 1711-1733 (2003).  
Zhao, Y. and R. H. Davis, "Interaction of Sedimenting Spheres with Multiple Surface  
Roughness Scales," *J. Fluid Mech.* 492, 101-129 (2003).  
Zinchenko, A. Z. and R. H. Davis, "Shear Flow of Highly-Concentrated Emulsions by  
Numerical Simulation," *J. Fluid Mech.* 455, 21-62 (2002).  
Davis, R. H., D. A. Rager, and B. T. Good, "Elastohydrodynamic Rebound of  
Spheres from Coated Surfaces," *J. Fluid Mech.* 468, 107-119 (2002).  
Mores, W. D. and R. H. Davis, "Yeast Foulant Removal by Backpulses in Crossflow  
Microfiltration," *J. Mem. Sci.* 208, 389-404 (2002).

- Mores, W. D. and R. H. Davis, "Direct Visual Observation of Yeast Deposition and Removal During Microfiltration," *J. Mem. Sci.* **189**, 217-230 (2001).
- Kushner, J., M. A. Rother, and R. H. Davis, "Buoyancy-driven Interactions of Viscous Drops with Deforming Interfaces," *J. Fluid Mech.* **446**, 253-270 (2001).
- Ma, H., C. N. Bowman, and R. H. Davis, "Membrane Fouling Reduction by Backpulsing and Surface Modification," *J. Mem. Sci.* **173**, 191-200 (2000).
- Breckenridge, N. C. and R. H. Davis, "Optimization of Repeated-batch Transcription for RNA Production," *Biotech. Bioeng* **69**, 679-687 (2000).
- Wilson, H. J. and R. H. Davis, "The Viscosity of a Dilute Suspension of Rough Spheres," *J. Fluid Mech.* **421**, 339-367 (2000).

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES – ACS, AIChE, APS, ASEE, NAMS

#### HONORS AND AWARDS

- 2003 Outstanding Service Award, Boulder Faculty Assembly, University of Colorado
- 2002 Joe and Essie Smith Distinguished Lecturer, U.C. Davis
- 2002 ASEE Dow Lectureship Award
- 2000 Outstanding Teaching Award, College of Engineering and Applied Science
- 2000 Outstanding Research Award, Boulder Faculty Assembly, University of Colorado
- 2000 Outstanding Graduate Teaching Award, Department of Chemical Engineering
- 1999 AIChE Excellence and Service Appreciation Award
- 1999 Outstanding Service Award, College of Engineering and Applied Science
- 1996 Outstanding Graduate Teaching Award, Department of Chemical Engineering
- 1995 AIChE Outstanding Paper Award
- 1993 Outstanding Research Award, College of Engineering and Applied Science
- 1990 Dow Outstanding Young Faculty Award, Rocky Mountain Section of ASEE
- 1990 Guggenheim Fellowship
- 1989 Outstanding Undergraduate Teaching in Chemical Engineering Award
- 1985 NSF Presidential Young Investigator Award
- 1982 NATO Postdoctoral Fellowship in Science
- 1978 University Medalist, University of California at Davis

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

- Dean, College of Engineering and Applied Science, University of Colorado, 2002-present
- Chair, Department of Chemical Engineering, University of Colorado, 1992-2002
- Director, Colorado RNA Center, 1992-2001
- Director, University of Colorado Biotechnology Training Program 1989-2003
- Co-Director, Colorado Institute for Research in Biotechnology, 1987-2001
- ASEE ChE Summer School Co-Chair, 2002
- NAMS 2000 Meeting Program Chair
- AIChE Annual Meeting Program Chair, 1999
- Guest Editor, Special Issue of *Chemical Engineering Education*, 1998
- ASEE ChE Summer School Workshop Organizer, 1997
- IUTAM Symposium Organizer, 1995
- AIChE Fluids Area Program Committee, 1988-97 (vice chair, 1992-96)

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

- ASEE ChE Summer School, 2002 (co-chair, speaker, mentor)
- Engineering New Faculty Program, U. Colorado, 2003- (organizer, presenter)

## JANET DEGRAZIA, SENIOR INSTRUCTOR

Department of Chemical and Biological Engineering

University of Colorado

Boulder, CO 80309-0424

Phone: (303) 492-7471 or -735-4763

Fax: (303) 492-4341

email: [deGrazia@colorado.edu](mailto:deGrazia@colorado.edu)

### EDUCATION

Ph.D. in Chemical Engineering, May 1998, University of Colorado

M.S. in Chemical Engineering, May 1994, University of Colorado

B.A. in Art History, May 1977, Barnard College

### PROFESSIONAL EXPERIENCE

Senior Instructor, Chemical and Biological Engineering, University of Colorado, 8/02 - present

Director of Outreach, Integrated Teaching and Learning Laboratory, 3/00 – 8/02

Senior Instructor, Chemical and Mechanical Engineering, University of Colorado, 3/00 – 8/02

Postdoctoral Fellow in SMET Education, Integrated Teaching and Learning Laboratory, 9/98 – 8/01

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

deGrazia, J.L., Sullivan, J.F., Carlson, L.E. and Carlson, D.W. (2001), "A K-12 / University Partnership: Creating Tomorrow's Engineers," *Journal of Engineering Education*, October 2001.

deGrazia, J.L., (2001), "Engineering Workshops for K-12 Schoolteachers," *Proceedings*, 2001 Frontiers in Education Conference, paper #1297.

deGrazia, J.L., Sullivan, J.F., Aragon, D.J. and Matthews, J.M. (2001), "Success Institute: Expanding the Pool of Under-Represented Minority Engineering Students," *Proceedings*, 2001 Frontiers in Education Conference, paper #1293.

deGrazia, J.L., Sullivan, J.F., Carlson, L.E. and Carlson, D.W. (2000), "Engineering in the K-12 Classroom: A Partnership that Works," *Proceedings*, 2000 Frontiers in Education Conference.

### SELECTED HONORS AND AWARDS

Charles Hutchinson Memorial Teaching Award, 2004

Department Faculty Mentor Award, 2004

Best Paper, ASEE Regional Conference, 2004

Department Faculty Undergraduate Teaching Award, 2003

Faculty Appreciation Award, Multicultural Engineering program, 2003

Best Paper, Frontiers in Education Conference, 1999, 2000

"Professor Who Makes A Difference", Mechanical Engineering, Spring 2000

Sullivan-Carlson Innovation in Teaching Award, Fall 1999

Outstanding Part-time Graduate Instructor, University of Colorado at Boulder, May 1996

Outstanding Teaching Assistant, Chemical Engineering 1993

### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Chair, Outreach committee (2000-present); Chair, Academic Ethics Committee (2000-present); Undergraduate Committee (2000 – present) ; Biological Degree Committee (2004 – present).

### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

ASEE Meetings (presenting/attending educational sessions) Annually  
FIE Meeting (presenting/attending educational sessions) 2000

**JOHN L. FALCONER, PROFESSOR**  
Department of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 492-8005  
Fax: (303) 492-4341  
email: [john.falconer@colorado.edu](mailto:john.falconer@colorado.edu)  
website: <http://www.colorado.edu/che/faculty/falconer/index.html>

#### EDUCATION

Ph.D., Chemical Engineering, Stanford University, 1974  
M.S., Chemical Engineering, Stanford University, 1968  
B.E.S., Chemical Engineering, The Johns Hopkins University, 1967

#### PROFESSIONAL EXPERIENCE

University of Colorado President's Teaching Scholar, 2000- present  
Professor of Chemical Engineering, University of Colorado, 1985-present  
Co-director: NSF-Research Experiences for Undergraduates Program in Membrane and Thin Film Science, 1993 – 2001, in Functional Materials 2003 - 2005  
Patten Professor of Chemical Engineering, University of Colorado, 1992 - 96  
Associate Professor, 1980 - 1985. Assistant Professor, 1975 - 1980.

#### CONSULTING, PATENTS

4 Issued U.S. Patents; 1 pending (filed) U.S. Patents

#### PROFESSIONAL LICENSING

Licensed PE – State of Colorado : Reg. Number 16909

#### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

1. Li, S., Tuan, V.A., Noble, R.D., and Falconer, J.L., "Properties and Separation Performance of Ge-ZSM-5 membranes," *Microporous Mesoporous Materials* **58**, 137-154 (2003).
2. Bowen, T. C., H. Kalipcilar, J.L. Falconer, and R.D. Noble, "Pervaporation of Organic/water Mixtures through B-ZSM-5 Zeolite Membranes on Monolith Supports," *J. Membrane Science* **215**, 235-247 (2003)
3. Gardner, T. Q., J.L. Falconer, R.D. Noble, and M. Zieverink, "Analysis of Transient Permeation Fluxes into and out Membranes for Adsorption Measurements," *Chem. Eng. Science* **58**, 2103-2112 (2003).
4. Tuan, V. A., L. L. Weber, J. L. Falconer, and R. D. Noble, "Synthesis of B-Substituted Beta Zeolite Membranes," *Ind. Eng. Chem. Research* **42**, 3019-3021 (2003).
5. Tuan, V.A., S. Li, R.D. Noble, and J.L. Falconer, "MTBE Adsorption on All-Silica Zeolite Beta," *Environmental Sci. Technol.* **37**, 4007-4010 (2003).
6. Sommer, S., T. Melin, J.L. Falconer, R.D. Noble, "Transport of C<sub>6</sub> Isomers through ZSM-5 Zeolite Membranes," *J. Membrane Science* **224**, 51-67 (2003).
7. Bowen, T.C., S. Li, J.L. Falconer, and R.D. Noble, "Driving Force for Pervaporation through Zeolite Membranes," *J. Membrane Science* **225**, 165-176 (2003).
8. Skoulidas, A.I., T.C. Bowen, J.L. Falconer, R.D. Noble, and D.S. Sholl, "Comparing Atomistic Simulations and Experimental Measurements for CH<sub>4</sub>/CF<sub>4</sub> Mixture Permeation through Silicalite Membranes," *J. Membrane Science* **227**, 123-136 (2003).
9. Preis, S. and J.L. Falconer, "Gas-Phase Photocatalytic Oxidation of Motor Fuel Oxygenated Additives," *J. Water Science Technol.* **49**, 141-145 (2004).
10. Kulprathipanja, A. and J.L. Falconer, "Partial Oxidation of Methanol for Hydrogen Production using ITO/Al<sub>2</sub>O<sub>3</sub> Nanoparticle Catalysts," *J. Applied Catalysis A* **261**, 77-86 (2004).

11. Bowen, T.C., Wyss, J.C., Noble, R.D., and Falconer, J.L., "Inhibition during Multicomponent Diffusion through ZSM-5 Zeolite," *Ind. Eng. Chem. Research* **43**, 2598-2601 (2004)
12. Bowen, T.C., Wyss, J.C., Noble, R.D., and Falconer, J.L., "Measurements of Diffusion through a Zeolite Membrane using Isotopic-Transient Pervaporation," *Microporous Mesoporous Materials* **71**, 199-210 (2004)
13. Kulprathipanja, A., G. O. Alptekin, J.L. Falconer, and J.D. Way, "The Effect of Water Gas Shift Gases on Pd-Cu Alloy Membranes," *Ind. Eng. Chem. Research* **43**, 4188-4198 (2004)
14. Li, S., J.L. Falconer, R.D. Noble, "SAPO-34 Membranes for CO<sub>2</sub>/CH<sub>4</sub> Separation," *J. Membrane Science* **241**, 121-135 (2004)
15. Gardner, T.Q., J.L. Falconer, and R.D. Noble, "Characterization of ZSM-5 and ZSM-11 Zeolite Membranes by Transient Permeation of Butanes," *AIChE Journal* **50**, 2816-2834 (2004).
16. Bowen, T.C., R.D. Noble, and J.L. Falconer, "Fundamentals and Applications of Pervaporation through Zeolite Membranes," *J. Membrane Science* **245**, 1-33 (2004)
17. Li, S., G. Alvarado, J.L. Falconer, R.D. Noble, "Effect of Impurities on CO<sub>2</sub>/CH<sub>4</sub> Separation in SAPO-34 Membranes," *J. Membrane Science* **251**, 59-66 (2005).

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

North American Catalysis Society; ACS; American Society of Engineering Education

#### HONORS AND AWARDS

University of Colorado CRCW Faculty Fellowship (2004-05)  
 Boulder Faculty Assembly Excellence in Research, Scholarly, and Creative Work Award (1999)  
 Chemical Manufacturers Association National Catalyst Award for Excellence in Teaching (1997)  
 University of Colorado CRCW Faculty Fellowship (1997-98)  
 ASEE Rocky Mountain Section Outstanding Teaching Award (1997)  
 Departmental Outstanding Graduate Teaching Award (1995, 1997, 1999, 2000)  
 AIChE Student Chapter Departmental Outstanding Undergraduate Teaching Award (1994)  
 ACS Colorado Section Award in Chemistry (1992)  
 College of Engineering Outstanding Advisor Award (1992)  
 College of Engineering Research Award (1991)  
 Charles Hutchinson Memorial Teaching Award, College of Engineering (1990)  
 University of Colorado CRCW Faculty Fellowship (1990-91)  
 Omega Chi Epsilon (Chem. Eng. Dept) Outstanding Professor Award (1988)  
 Ralph R. Teetor Award, Society Automotive Engineers (1978)  
 University of Colorado Summer Research Initiation Fellowship (1975)

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Internal Advisory Board for 5<sup>th</sup> Internal Congress on Spillover, Madrid, Spain 2001; Scientific committee for 4<sup>th</sup> Internal Conference on Catalysis in Membrane Reactors, Zaragoza, Spain, 2000; 5<sup>th</sup> International TiO<sub>2</sub> Water and Air Purification Conferences, 2000; International advisory board for 5<sup>th</sup> International Conference on Catalysis in Membrane Reactors, 2002, Dalian, China; Proposal and Journal Reviewer

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

Attend numerous national and international meetings (presenting/attending research and educational sessions) annually

**STEVEN M. GEORGE, PROFESSOR**

Dept. of Chemistry and Biochemistry  
Dept. of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO. 80309  
(303)-492-3398 Office  
(303)-492-5894 FAX

Email: [Steven.George@Colorado.Edu](mailto:Steven.George@Colorado.Edu) Email

Research Group Website: <http://www.colorado.edu/Chemistry/GeorgeResearchGroup/>

**EDUCATION:**

- University of California, Berkeley, Calif.; Ph. D. in Chemistry, March 1983; Thesis: "Picosecond Studies of Vibrational Linewidth Broadening in Liquids".
- Yale University, New Haven, Conn.; B.S. in Chemistry with highest honors, May 1977.
- Phillips Exeter Academy, Exeter N.H.; Graduated with high honors, June 1973.

**PROFESSIONAL EXPERIENCE:**

- Professor, Dept. of Chemical and Biological Engineering, Univ. of Colorado, Boulder, Colorado, August 2001-Present.
- Professor, Dept. of Chemistry and Biochemistry, Univ. of Colorado, Boulder, Colorado, Sept. 1995- Present.
- Associate Professor, Dept. of Chemistry and Biochemistry, Univ. of Colorado, Boulder, Colorado, Jan. 1992- August 1995.
- Assistant Professor, Dept. of Chemistry, Stanford University, Stanford, Calif., Fall 1984 - Dec. 1991.
- Visiting Scientist: Exxon Corporate Research, Laboratories, Linden, N.J., Summer 1983 - Fall 1984.

**TEN SIGNIFICANT PUBLICATIONS**

1. S.M. George, A.W. Ott and J.W. Klaus, "Surface Chemistry for Atomic Layer Growth", Special Centennial Issue of *J. Phys. Chem.* **100**, 13121 (1996).
2. R.M. Costescu, D.G. Cahill, F.H. Fabreguette, Z.A. Sechrist and S.M. George, "Preparation of Ultra-Low Thermal Conductivity W/Al<sub>2</sub>O<sub>3</sub> Nanolaminates", *Science* **303**, 989 (2004).
3. J.W. Klaus, S.J. Ferro and S.M. George, "Atomic Layer Deposition of Tungsten Using Sequential Surface Chemistry with a Sacrificial Stripping Reaction", *Thin Solid Films* **360**, 145 (2000).
4. J.W. Elam, C.E. Nelson, R.K. Grubbs and S.M. George, "Nucleation and Growth During Tungsten Atomic Layer Deposition on SiO<sub>2</sub> Surfaces", *Thin Solid Films* **386**, 41-52 (2001).
5. J.W. Elam, D. Routkevitch, P.P. Markilovich and S.M. George, "Conformal Coating on Ultrahigh-Aspect-Ratio Nanopores of Anodic Alumina by Atomic Layer Deposition", *Chem. Mater.* **15**, 3507-3517 (2003).
6. J.D. Ferguson, A.W. Weimer and S.M. George, "Atomic Layer Deposition of Ultrathin and Conformal Al<sub>2</sub>O<sub>3</sub> Films on BN Particles", *Thin Solid Films* **371**, 95 (2000).

7. J.R. Wank, S.M. George and A.W. Weimer, "Vibro-fluidization of Fine Boron Nitride Powder at Low Pressure", *Powder Technology* **121**, 195-204 (2001).
8. J.W. Klaus, O. Sneh and S.M. George, "Atomic Layer Controlled SiO<sub>2</sub> Growth at Room Temperature using Catalyzed Binary Reaction Sequence Chemistry", *Science* **278**, 1934 (1997).
9. J.D. Ferguson, A.W. Weimer and S.M. George, "Atomic Layer Deposition of Al<sub>2</sub>O<sub>3</sub> Films on Polyethylene Particles", *Chem. Mater.* **16**, 5602-5609 (2004).
10. M.D. Groner, F.H. Fabreguette, J.W. Elam and S.M. George, "Low Temperature Al<sub>2</sub>O<sub>3</sub> Atomic Layer Deposition", *Chem. Mater.* **16**, 639-645 (2004).

#### **CURRENT AND RECENT PROFESSIONAL ACTIVITIES:**

- Chair, International Symposium of the American Vacuum Society, October 30-November 4, 2005, Boston, Massachusetts
- Member, Conference Committee for American Vacuum Society Topical Conference on *Atomic Layer Deposition* (ALD 2005), August 8-10, 2005, San Jose, California
- Member, Conference Committee for American Vacuum Society Topical Conference on *Atomic Layer Deposition* (ALD 2004), August 16-18, 2004, Helsinki, Finland
- Member, Conference Committee for American Vacuum Society Topical Conference on *Atomic Layer Deposition* (ALD 2003), August 3-6, 2003, San Jose, California
- Chair, *Thin Film Division* of the American Vacuum Society, January - December 2002.
- Member, Conference Committee for American Vacuum Society Topical Conference on *Atomic Layer Deposition* (ALD 2002), August 19-21, 2002, Seoul, Korea
- Co-Founder, ALD NanoSolutions, Fall 2001.
- Chair, American Vacuum Society Topical Conference on *Atomic Layer Deposition* (ALD 2001), May 14-15, 2001, Monterey, California.
- Vice Chair, *Thin Film Division* of the American Vacuum Society, January - December 2001.
- Member, *Thin Film Division Program Committee* for National American Vacuum Society Meeting, October 1999-Present.
- Member, *Board of Editors*, *Surface Review and Letters*, January 1998-Present.

#### **AFFILIATIONS:**

American Chemical Society; American Physical Society; American Vacuum Society; Materials Research Society.

#### **FELLOWSHIPS AND AWARDS:**

American Chemical Society Colorado Section Award, 2004  
 R&D 100 Award for *Particle-ALD*<sup>™</sup>, 2004  
 Inventor of the Year, University of Colorado at Boulder, 2004  
 National Science Foundation Creativity Award, 2002-2004  
 Fellow, American Vacuum Society, 2000  
 Fellow, American Physical Society, 1997  
 Presidential Young Investigator Award, 1988-1993  
 Alfred P. Sloan Foundation Fellow, 1988

## RYAN T. GILL, ASSISTANT PROFESSOR

Department of Chemical and Biological Engineering

University of Colorado

Boulder, CO 80309-0424

Phone: (303) 492-2627

email: [rtg@colorado.edu](mailto:rtg@colorado.edu)

website: <http://www.colorado.edu/che/gillgroup/gillweb/index.htm>

### EDUCATION

Ph.D., Chemical Engineering, University of Maryland, 1999

M.S., Chemical Engineering, University of Maryland, 1997

B.S., Chemical Engineering, The Johns Hopkins University, 1993

### PROFESSIONAL EXPERIENCE

University of Colorado, Boulder, CO (2001-present), Assistant Professor

Massachusetts Institute of Technology, Cambridge, MA (1999-2001), Post-doctoral Associate

### CONSULTING, PATENTS

1 Issued U.S. Patents; 6 pending (4 filed) U.S. Patents

### PROFESSIONAL LICENSING

Engineering in Training (1993)

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- (1) **Gill, R.T.**, Valdes, J.J., and Bentley, W.E.\* 2000. A comparative study of global stress gene regulation in response to overexpression of recombinant proteins in *Escherichia coli*. *Metabolic Engineering*. 2:3:178-189.
- (2) **Gill, R.T.**, Shiloach, M.<sup>1</sup>, Delisa, M.P., Holoman, T.R., and Bentley, W.E.\* 2000. A Novel OmpT Activity: Increased proteolytic activity in response to foreign protein overproduction and amino acid limitation. *Journal of Microbiology and Molecular Biotechnology*. 2:3:283-289.
- (3) **Gill, R.T.**, DeLisa, M.P., Valdes, J.J., and Bentley, W.E.\* 2000. Genomic Analysis of High Cell Density Recombinant *Escherichia coli* Fermentation and "Cell Conditioning" for Improved Recombinant Protein Yield. *Biotechnology and Bioengineering*. 72:1:85-95.
- (4) Stephanopoulos, G.\* and **Gill, R.T.** 2000. After a Decade of Progress, an Expanded Role for Metabolic Engineering. *Advances in Biochemical Engineering*. 73:1-8. Springer. New York, NY.
- (5) Taroncher-Oldenburg, G., **Gill, R.T.** and Stephanopoulos, G.\* 2000 Green biosynthesis of polyhydroxyalkanoates: Engineering of cyanobacteria for biopolymer production. In: Proceedings 4th annual green chemistry and engineering conference. American Chemical Society, Washington, D.C., June 2000, pp. 61-4.
- (6) **Gill, R.T.**, Katsoulakis, E.<sup>1</sup>, Schmitt, W., Taroncher-Oldenburg, G., and Stephanopoulos, G.\* 2002. Whole Genome Dynamic Transcriptional Profiling of the Light-Dark Transition in *Synechocystis* sp. PCC6803. *Journal of Bacteriology*. 184:3671-3681.

- (7) **Gill, R.T.**, Wildt, S., Yang, Y., Ziesman, S., and Stephanopoulos, G.\* 2002. Genome wide screening for trait conferring genes using DNA micro-arrays. *Proceedings of the National Academy of Sciences*.99:10:7033-7038.
- (8) **Gill, R.T.\*** 2003. Enabling Inverse Metabolic Engineering through Genomics. *Current Opinions in Biotechnology*. 14:5:484-490.
- (9) Lynch, M., **Gill, R.T.\***, and Stephanopoulos, G. 2004. Mini-Review: Mapping phenotypic landscapes using DNA micro-arrays. *Metabolic Engineering*. 6:177-185.
- (10) **Gill, R.T.** and Dodge, T. 2004. Foreword to the Special issue on inverse metabolic engineering. 6:175-176. (not peer reviewed, was Guest editor of edition)
- (11) Bonomo, J. and **Gill, R.T.\*** 2004. Metabolic engineering: Applying systems biology to a clinically relevant problem. *Computers and Chemical Engineering*. In-Press.
- (12) Dai, M., Ziesman, S., Ratcliffe, T. <sup>1</sup>, **Gill, R.T.**, and Copley, S.C\*. 2004. Visualization and Quantification of protoplast fusion in *Escherichia coli*. *Metabolic Engineering*. In press.
- (13) Bonomo, J. and **Gill, R.T.\*** 2004. Amino-acid content of recombinant proteins influences the metabolic burden response. *Biotechnology and Bioengineering*. 90:116-126.
- (14) Hume, P. <sup>1</sup> and **Gill, R.T.\*** 2005. Transcriptional profiling of the heat shock response of *Burkholderia cenocepacia*. *Submitted*.

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, American Chemical Society, American Society for Microbiology

#### HONORS AND AWARDS

2005 National Science Foundation CAREER Award  
 2005 National Institutes of Health CAREER (K) Development Award  
 2004 Subaru Educator Spotlight Award  
 2003 CU-Boulder, Department of Chemical Engineering, Undergraduate Advising Award  
 2001 Vern Norviel Junior Faculty Award

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

*Session chairs* at AIChE, ACS, Metabolic Engineering, Biochemical Engineering national and international meetings. *Reviewer* for Nature Biotechnology, Applied Environmental Microbiology, Biotechnology and Bioengineering, Metabolic Engineering, Physiological Genomics, Biotechnology Progress, National Science Foundation, National Institutes of Health.

*Institutional Service* - Genomics Advisory Committee for the University of Colorado Biological Sciences Initiative, University of Colorado Molecular Biotechnology Initiative, Co-director of CU-Boulder Gene Expression Facility, College of Engineering's committee on Bioengineering

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

AIChE, ACS, ASM Meetings (presenting/attending research & educational sessions) Annually

## DOUGLAS L. GIN, ASSOCIATE PROFESSOR

Department of Chemical and Biological Engineering, and  
Department of Chemistry and Biochemistry  
University of Colorado  
Boulder, CO 80309-0424

Phone: (303) 492-7640 or -735-1107

email: [gin@spot.colorado.edu](mailto:gin@spot.colorado.edu)

website: [www.colorado.edu/research/gingroup/](http://www.colorado.edu/research/gingroup/)

### EDUCATION

Ph.D., Chemistry, California Institute of Technology, 1993

B.Sc (Honours)., Chemistry, University of British Columbia (Canada), 1988

### PROFESSIONAL EXPERIENCE

University of Colorado, Boulder, CO (2001-present)

2001-present: Associate Professor, Department of Chemical Engineering

University of California, Berkeley, CA (1994-2001)

1994-2001: Assistant Professor, Department of Chemistry

Lawrence Berkeley National Laboratory, Berkeley, CA (1994-2001)

1994-2001: Faculty Scientist

University of Pennsylvania, Philadelphia, PA (1992-1994)

1992-1994: NSERC Canada postdoctoral fellow, Department of Chemistry

### CONSULTING, PATENTS

4 issued U.S. Patents, and 5 U.S. patent applications; part time consultant to Alnis, LLC, and Eeonyx Corp.; prior consultant to numerous law firms in the San Francisco area and to Levis-Strauss Co.

### PRINCIPAL PUBLICATIONS OVER LAST FIVE YEARS

- (1) Martin, A. G.; Harms, S.; Weigand, W.; Gin, D. L. "Polymerizable Transition-metal-containing Liquid Crystals with Thermally Reactive 1,3-Diene Tails," *Adv. Mater.* **2005**, *17* (5), 602-606.
- (2) Jin, J.; Nguyen, V.; Gu, W., Lu, X.; Elliott, B. J.; Gin, D. L. "Cross-linked Lyotropic Liquid Crystal-Butyl Rubber Composites: Promising "Breathable" Barrier Materials for Chemical Protection Applications," *Chem. Mater.* **2005**, *17* (2), 224-226.
- (3) Hoag, B. P.; Gin, D. L. "Polymerisable Hexacatenar Mesogens Containing a Luminescent Oligo(*p*-phenylenevinylene) Core," *Liq. Cryst.* **2004**, *31* (2), 185-199.
- (4) Xu, Y.; Gu, W.; Gin, D. L. "Heterogeneous Catalysis Using a Nanostructured Solid Acid Resin Based on Lyotropic Liquid Crystals," *J. Am. Chem. Soc.* **2004**, *126* (6), 1616-1617.
- (5) Zhou, W.-J.; Gu, W.; Xu, Y.; Pecinovsky, C. S.; Gin, D. L. "Assembly of Acidic Amphiphiles into Inverted Hexagonal Phases Using an L-Alanine-based Surfactant as a Structure-Directing Agent," *Langmuir* **2003**, *19*, 6346-6348.
- (6) Sentman, A. C.; Gin, D. L. "Polymerizable Bent-core Mesogens: Switchable Precursors to Ordered Polar Polymer Materials," *Angew. Chem. Int. Ed.* **2003**, *42* (16), 1815-1819.

- (7) Pindzola, B. A.; Jin, J.; Gin, D. L. "Cross-Linked Normal Hexagonal and Bicontinuous Cubic Assemblies via Polymerizable Gemini Amphiphiles," *J. Am. Chem. Soc.* **2003**, *125* (10), 2940–2949.
- (8) Hammond, S. R.; Zhou, W.-J.; Gin, D. L.; Avlyanov, J. K. "Synthesis and Lyotropic Liquid Crystalline Behavior of a Taper-Shaped, Phosphonic Acid Amphiphile," *Liq. Cryst.* **2002**, *29* (9), 1151–1159.
- (9) Gin, D. L.; Gu, W.; Pindzola, B. A.; Zhou, W.-J. "Polymerized Lyotropic Liquid Crystal Assemblies for Materials Applications," *Acc. Chem. Res.* **2001**, *34*, 973–980.
- (10) Gu, W.; Zhou, W.-J.; Gin, D. L. "A Nanostructured, Scandium-Containing Polymer for Heterogeneous Lewis Acid Catalysis in Water," *Chem. Mater.* **2001**, *13* (6), 1949–1951.

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Chemical Society, American Institute of Chemical Engineers, Materials Research Society, International Liquid Crystal Society

#### HONORS AND AWARDS

2002 CU Boulder Residence Life Teaching Excellence Award  
 1999 ACS PMSE/YCC Young Contributor to Polymer Materials Science  
 1999 Alfred P. Sloan Foundation Research Fellow  
 1997 Research Corporation Cottrell Teacher/Scholar Award  
 1996 National Science Foundation CAREER Award  
 1996 3M Nontenured Faculty Award (4 times through to 2000)  
 1996 Regents' Junior Faculty Fellowship, U.C. Berkeley  
 1992 NSERC Canada Postdoctoral Fellowship  
 1992 Finalist, Sherwin–Williams Graduate Student Award Competition, ACS  
 1998 NSERC Canada 1967 Science and Engineering Graduate Scholarship

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Space Committee Chair, Dept. of Chem. & Biol. Engineering, CU Boulder (2004–present); Undergraduate Materials Option Co-advisor, Dept. of Chemical Engineering, CU Boulder (2003–present); Member, Graduate committee, Dept. of Chem. & Biol. Engineering Graduate Committee, CU Boulder (2002–present); Chair, Dept of Chemistry & Biochemistry Graduate Admissions Committee, CU Boulder (2002–present); Meeting organizer for the "Frontiers in Liquid Crystals and Molecular Self-Assembly" workshop, University of Colorado (2004); Co-organizer for the symposium on "Polymer Chemistry in Nanotechnology" in the Division of Polymer Chemistry, 226th ACS National Meeting (2003); Meeting co-organizer and co-chair of the chemistry session for the 2002 National Academy of Science Chinese-American Frontiers of Science symposium (2002); Co-organizer for the symposium on "Organic Methodologies in the Selective Synthesis of Small Molecules and Materials" in the Division of Organic Chemistry, 224th ACS National Meeting (2002); Co-chair and co-organizer for the chemistry session of the 2001 National Academy of Science Chinese–American Frontiers of Science symposium, Beijing, China (2001).

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

ACS and AIChE Meetings (presenting/attending research sessions) annually; MRS Meetings (presenting/attending research sessions) biannually.

## CHRISTINE M. HRENYA – ASSOCIATE PROFESSOR

Department of Chemical and Biological Engineering

University of Colorado - UCB 424

Boulder, CO 80309-0424

(303) 492-7689 (303) 492-4341 (fax)

[hrenya@colorado.edu](mailto:hrenya@colorado.edu)

<http://www.colorado.edu/che/faculty/hrenya.html>

### EDUCATION

Carnegie Mellon University, Pittsburgh, PA (Aug 91 – May 96)

Ph.D. in Chemical Engineering

Dissertation Title: *Dense, Turbulent Gas-Solid Flows in Vertical Risers*

Advisor: Professor Jennifer Sinclair Curtis

The Ohio State University, Columbus, OH (Sep 87 – Jun 91)

B.S. in Chemical Engineering, *summa cum laude*

### PROFESSIONAL EXPERIENCE

University of Colorado at Boulder, Department of Chemical and Biological Engineering,

Associate Professor (Feb 2005 - present) and Department of Applied Mathematics,

Affiliated Faculty (Mar 2003 – present)

University of Colorado at Boulder, Department of Chemical and Biological Engineering,

Assistant Professor (Aug 1998 – Feb 2005)

Honeywell Technology Center, Minneapolis, MN (Jun 1996 – Jul 1998)

The Dow Chemical Company, Midland, MI (Summer 1995)

E. I. du Pont de Nemours & Co., Circleville, OH (Summer 1991)

The Dow Chemical Company, Granville, OH (Summer 1990)

Eastman Kodak Co., Rochester, NY (Summer 1989)

E. I. du Pont de Nemours & Co., Circleville, OH (Summer 1988)

### HONORS AND AWARDS

NSF POWRE Award (1999), University of Colorado Junior Faculty Development Award

(1999), AIChE Particle Technology Forum Award for Best Ph.D. in Particle Technology

(1997), DuPont Ph.D. Fellowship (1991-1995), Carnegie Fellowship (1991-1993)

### JOURNAL PUBLICATIONS in last 3 years (corresponding author underlined)

1. R. B. Rice and C. M. Hrenya, "Impact of Binary Size Distribution on Clustering in Granular Shear Flows," *Physical Review Letters*, submitted.
2. J. K. Walsh, A. W. Weimer, and C. M. Hrenya, "Thermophoretic deposition of aerosol particles in laminar tube flow with mixed convection," *Journal of Aerosol Science*, submitted.
3. A. Stevens and C. M. Hrenya, "Comparison of soft-sphere models to measurements of collision properties during normal impacts," *Powder Technology*, submitted.
4. S. R. Dahl and C. M. Hrenya, "Size Segregation in Gas-Solid Fluidized Beds with Continuous Particle Size Distributions," *AIChE Journal*, submitted.
5. H. Iddir, H. Arastoopour, and C. M. Hrenya, "Rheology of binary and ternary granular mixtures using kinetic theory approach," *Powder Technology*, in press.
6. J. E. Galvin, S. R. Dahl, and C. M. Hrenya, "On the role of non-equipartition in the dynamics of rapidly-flowing, granular mixtures," *Journal of Fluid Mechanics*, **528**, 207-232 (2005).

7. M. W. Weber, D. K. Hoffman, and C. M. Hrenya, "Discrete-particle simulations of cohesive granular flow using a square-well potential," *Granular Matter*, **6**, 239-254 (2004).
8. S. R. Dahl and C. M. Hrenya, "Size Segregation in Rapid, Granular Flows with Continuous Size Distributions," *Physics of Fluids*, **16**, 1-13 (2004).
9. S. R. Dahl, R. Clelland, and C. M. Hrenya, "Three-dimensional, Rapid Shear Flow of Particles with Continuous Size Distributions," *Powder Technology*, **138**, 7-12 (2003).
10. S. R. Dahl, C. M. Hrenya, V. Garzó, and J. W. Dufty, "Kinetic Temperatures for a Granular Mixture," *Physical Review E*, **66**, art. no. 041301 (2002).
11. J. A. Johnson, W. B. Krantz, C. M. Hrenya, and A. W. Weimer, "Sensitivity Analysis of the Rapid Carbothermal Reduction Synthesis of Ultra-Fine Silicon Carbide Powders," *Journal of Aerosol Science and Technology*, **36**, 1087-1098 (2002).
12. J. A. Johnson, C. M. Hrenya, and A. W. Weimer, "Intrinsic Reaction and Self-Diffusion Kinetics for Silicon Carbide Synthesis by Rapid Carbothermal Reduction," *Journal of the American Ceramic Society*, **85**, 2273-2280 (2002).
13. S. R. Dahl, R. Clelland, and C. M. Hrenya, "The Effects of Continuous Size Distributions on the Rapid Flow of Inelastic Particles," *Physics of Fluids*, **14**, 1972-1984 (2002).
14. R. Clelland and C. M. Hrenya, "Simulations of a Binary-sized Mixture of Inelastic Grains in Rapid Shear Flow," *Physical Review E*, **65**, art. no. 031301 (2002).

INSTITUTIONAL SERVICE in last 5 years: Chair, Centennial Celebration Committee (Aug 2003 – present); PhD Preliminary Examination Panel (Aug 2003 – present); Chair, PhD Preliminary Examination Committee (Aug 2003 – Aug 2004); Program Committee (Aug 2002 – Aug 2004); Faculty Search Committee (Sep 2002 – May 2003); Director, Graduate Program (Aug 2001 – Aug 2002); Instructor for High School Honors Institute (Aug 2001); Instructor for ITLL K-12 Teacher Workshops (Jul 2000); Instructor in Success Institute for Underrepresented Pre-college Students (Jun 2000); Reviewer of Undergraduate Research Opportunities Program (UROP) Proposals (Fall 2000, Fall 2001, Spring 2002); Reviewer for Beverly Sears Dean's Small Grants (Spring 2000)

PROFESSIONAL SERVICE in last 5 years: *Conference Organizing Committees:* Chair (elected) – 2006 Gordon Research Conference on Granular and Granular-Fluid Flows, Social Functions Director – 2006 World Congress of Particle Technology V, Vice Chair (elected) – 2004 Gordon Research Conference on Granular and Granular-Fluid Flows. *Technical Committees:* Newsletter Editor – AIChE Particle Technology Forum (PTF) (Aug 2002 – present) - AIChE Marx Isaacs Newsletter Award (2003), Executive Committee – AIChE Particle Technology Forum (PTF) (Nov 2004 – present). *Technical Session Chaired or Co-Chaired:* 8 total (AIChE, UEF, WCPT4), *Reviewer:* active reviewer for >15 journals, NSF, ACS, numerous conferences, and textbook. *Journal Editorial Duties:* Guest co-editor (with Prof. Alan Weimer as Guest Editor) of special issue of *Powder Technology* on Engineered Particle Processing (2004-5)

PROFESSIONAL DEVELOPMENT in last 5 years: Chairing, presenting and attending research and education sessions at annual AIChE meetings and numerous international meetings.

PROFESSIONAL AFFILIATIONS: American Chemical Society (ACS), American Institute of Chemical Engineers (AIChE), American Physical Society (APS), American Society of Engineering Education (ASEE).

DHINAKAR S. KOMPALA, ASSOCIATE PROFESSOR  
Department of Chemical and Biological Engineering  
University of Colorado, Boulder CO 80309-0424  
Phone: 303-492-6350 Fax: 303 492 7471  
<http://www.colorado.edu/che/kompala.html>

## EDUCATION

B. Tech., Chemical Engineering, I.I.T., Madras, India, July 1974 - June 1979  
M.S., Chemical Engineering, Purdue University, August 1979 - July 1982  
Ph.D., Chemical Engineering, Purdue University, August 1982 - December 1984

## PROFESSIONAL EXPERIENCE

Associate Professor, University of Colorado, July 1991 - Present  
Visiting Professor, Internatl Center for Biotechnology, Osaka Univ., Feb - April, 1999  
Visiting Professor, Natl Renewable Energy Laboratory, Golden, July 1998 - Jan 1999  
Visiting Associate, California Institute of Technology, July 1991 - June 1992  
Assistant Professor, University of Colorado, January 1985 - June 1991

## CONSULTING (in the last five years)

Merck, Bolder Biotechnology, Eli Lilly

## PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

1. James, R.I., J.P. Elton, P. Todd, and D.S. Kompala, "Engineering CHO cells to overexpress a secreted reporter protein upon induction from mouse mammary tumor virus promoter," **Biotechnology and Bioengineering** **67**: 134-140 (2000).
2. Kompala, D.S., "Cell Growth and Protein Expression Kinetics", p. 383-392 *in* **The Encyclopedia of Cell Technology**, Ed.-in-Chief: Raymond E. Spier, John Wiley, 2000.
3. Murthy, M.V.M., A.O'Brien, R.I. James, and D.S. Kompala, "Overexpression of secreted reporter protein by mouse mammary tumor virus promoter: Effect of glucocorticoid receptor" p. 13-22, **Proceeding of 30<sup>th</sup> Annual Biochemical Engineering Symposium**, Ed. D.S. Kompala, University of Colorado, Boulder, September 2000.
4. Gao, Qiang, James D. McMillan, Min Zhang, and Dhinakar S. Kompala, "Comparative ethanol fermentation performance of xylose-utilizing *Zymomonas mobilis* strains in mixed glucose-xylose media" p. 65-74, **Proceeding of 30<sup>th</sup> Annual Biochemical Engineering Symposium**, Ed. D.S. Kompala, University of Colorado, Boulder, September 2000.
5. Murthy, M.V.M., M.L. Lipscomb, and D.S. Kompala, "Overexpression of a transcription factor to maximize glycoprotein production in an inducible expression system", p. 58-63 *in* **Animal Cell Technology – From Target to Market**, Ed. E. Lindner-Olsson, N. Chatzissavidow and E. Lullau, Kluwer Academic Publishers, The Netherlands, 2001.
6. Gao, Qiang, Min Zhang, James D. McMillan, and Dhinakar S. Kompala, "Characterization of Heterologous and Native Enzyme Activity Profiles in Metabolically Engineered *Zymomonas mobilis* Strains During Batch Fermentation of Glucose and Xylose Mixtures" **Applied Biochemistry and Biotechnology**, vol. 98: 341-355, 2002.
7. Mangalampalli V.R.M., M.C. Mowry, M.L. Lipscomb, M.L. Girouard, R.I. James, A.K. Johnson, and D.S. Kompala, "Increased production of a secreted glycoprotein in engineered

CHO cells through amplification of a transcription factor”, **Cytotechnology** 38: 23-35, 2002.

8. Lipscomb, M.L., M.C. Mowry, and D.S. Kompala, “Production of a secreted glycoprotein reporter from an inducible promoter system in a perfusion bioreactor”, **Biotechnology Progress** 20(5): 1402-1407, 2004.
9. Lipscomb, M.L., L.A. Palomares, V. Hernandez, O.T. Ramirez, and D.S. Kompala, “Effect of production method and gene amplification on the glycosylation pattern of a secreted reporter protein in CHO cells”, **Biotechnology Progress** 21 (1): 40-49 (2005).
10. D.S. Kompala, and S.S. Ozturk, “Optimization of high cell density perfusion cultures” Invited review article, in **Cell Culture Technology for Pharmaceutical and Cellular Therapies**, Ed.: S.S. Ozturk and W.-S. Hu, CRC Press, 2005 (in press).
11. Altintas, M.M., C. Eddy, M. Zhang, J.D. McMillan, and D.S. Kompala, “Kinetic modeling of the non-linear enzymatic reaction kinetics to optimize engineered pentose fermentation in *Zymomonas mobilis*” (under review).

### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineering, Society of Biological Engineering, American Chemical Society

### HONORS AND AWARDS

Presidential Young Investigator, National Science Foundation, 1988-1993

### PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Ad hoc Reviewer, Panelist, and Site-Visit Teams: National Science Foundation  
Editorial Board Member: Journal of Biotechnology, BioMedCentral Biotechnology,  
Reviewer for Journals: Biotechnology Progress, Biotechnology and Bioengineering,  
Bioprocess Engineering, Journal of Theoretical Biology, J. Biotechnology,  
Mathematical Biosciences, Metabolic Engineering, Computer and Chemical  
Engineering, AIChE Journal, Chemical Engineering Science, Chemical  
Engineering Education, Molecular Therapy, etc.

Organizing Committee, Engineering Foundation Conference on “Metabolic Engineering III”, Colorado Springs, October 22-27, 2000. “Cell Culture Engineering VIII”, Snowmass, Colorado, April 2-7, 2002. “Cell Culture Engineering IX”, Cancun, Mexico, March 7 – 12, 2004..

Program Vice-Chair, AIChE National Meeting, area 15c “Biotechnology”, November 2000. Program Chair, AIChE National Meeting, area 15c “Biotechnology”, November 2001.

Organizing Committee: Topical conference on Pharmaceutical Biotechnology: Discovery, Development, and Delivery of Medicine” at AIChE national meeting, November 2001.

**BEVERLY LOUIE**  
DIRECTOR  
Women in Engineering Program  
SENIOR INSTRUCTOR  
Department of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO 80309-0422  
Phone: 303-492-4967, Fax: 303-492-5414

Education

1993	<b>University of Oxford</b>	D.Phil., Mechanical Engineering
1983	<b>University of Colorado</b>	M.S., Chemical Engineering
1977	<b>University of Colorado</b>	B.S., Chemical Engineering

Professional Experience

1995-Present **University of Colorado**, Boulder, Colorado – Senior Instructor, Department of Chemical and Biological Engineering. Director, Women in Engineering Program

1983-2000 **National Institute of Standards and Technology**, Boulder, Colorado – Research Chemical Engineer

1978-1981 **Pacific Power and Light**, Gillette and Casper, Wyoming – Plant Chemist, Water Treatment Engineer

1977-1978 **Amoco Production Company**, Denver, Colorado – Process Engineer

Principle Publications of Last Five Years

- (1) Louie, B. and Aragon, D., A Model Partnership for WIEP and MEP, paper and workshop to be presented at 2005 WEPAN-NAMEPA Third Joint Conference, Las Vega, NV, April 2005.
- (2) Louie, B., Knight, D. and Sullivan, J., Women’s Manufacturing Workshop Series that Supports Inclusiveness and Skill Building in Undergraduate Engineering Education, Conference Proceedings of ASEE 2003 Annual Conference and Exposition, Nashville, TN, June 2003.
- (3) Sullivan, J.F., Reamon, D. and Louie, B. (2003), “Girls Embrace Technology: A Summer Internship for High School Girls,” Proceedings, Frontiers in Education Annual Conference, Boulder, Colorado, November 2003, paper #1159, pp. T4D-6 – T4D-11, Session T4D.
- (4) Watts, L. and B. Louie, Apparatus for measuring vapor-liquid equilibria and phase densities of complex aqueous solutions, Intl. J. Thermophysics, September (2000).

Textbook

J. Abarca, A.J. Bedard, D.W. Carlson, L.E. Carlson, J. Hertzberg, B. Louie, J. Milford, R. Reitsma, T. L. Schwartz and J.F. Sullivan, (2000) *“Introductory Engineering Design: A Projects-Based Approach,”* Third Edition, Textbook for GEEN 1400: First-Year Engineering Projects and GEEN 3400: Innovation and Invention, ITL Program and Laboratory, College of Engineering and Applied Science, University of Colorado at Boulder.

### Scientific and Professional Societies

Society of Women Engineers, American Association of Engineering Educators, Women in Engineering Program Advocates Network

### Professional Development in the Last Five Years

Invited Speaker, ASEE Engineering Dean's Institute, How to Improve Student Retention and Outreach, Santa Monica, California, March 24, 2003

### Honors and Awards

2001 Humanitarian Service Award – Rocky Mountain Survivors Center, Prosthetic arm project

2003 Suburu Educator Spotlight Award

2005 Chancellor's Committee on Women Program Award

### Institutional, Professional & Volunteer Service in the Last Five Years

Women in Engineering Program – Corporate Advisory Board, Engineering Career Day for Women, Girl Scout Badge Days, Resource Center, Advising, Engineering Workshops, Take Our Children to Work Day, Junior Solar Sprint, Scholarship Awards

Department of Chemical and Biological Engineering – Cooperative Education Coordinator and Student advisor, Undergraduate Curriculum Committee, Industry Relations Committee

College of Engineering and Applied Science – Engineers Without Borders Advisory Board, Undergraduate Council

University of Colorado at Boulder – Undergraduate Academy (Honors Program) Faculty Advisory Board

Integrated Teaching and Learning Program – GEEN 1400 Engineering Projects Coordinator

National Visiting Committee – Southwestern Indian Polytechnic Institute NSF ATE Program

Society of Women Engineers – Faculty Advisor for CU Student Chapter

Women in Engineering Programs and Advocacy Network – 2005 Conference Paper Reviewer

National Sports Center for the Disabled – Volunteer Sit-Ski Instructor, Developed student engineering projects such as sit-ski roll bars, outrigger handles and overmitts

South Boulder Little League – President, Board Member, Coach

YWCA of Boulder County – Board Member

Boulder County Force Soccer Club – Team Manager, Volunteer Coordinator

## MELISSA J. MAHONEY, ASSISTANT PROFESSOR

Department of Chemical and Biological Engineering

University of Colorado

Boulder, CO 80309-0424

Phone: (303) 492-3573

Fax: (303) 492-4341

email: [melissa.mahoney@colorado.edu](mailto:melissa.mahoney@colorado.edu)

### EDUCATION

Post-Doc, Chemical Engineering, University of Colorado, 2004

Post-Doc, Neurobiology, Duke University, 2002

Ph.D., Chemical Engineering, Cornell University, 2000

B.S., Chemical Engineering, Northwestern University, 1995

### PROFESSIONAL EXPERIENCE

University of Colorado, Boulder, CO (2005-present)

2005 – present: Assistant Professor, Department of Chemical Engineering

### CONSULTING, PATENTS

N/A

### PROFESSIONAL LICENSING

N/A

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- (1) Mahoney, MJ and KS Anseth, "Direct Visualization of Tissue Development and Function in Three Dimensional Materials by Confocal Microscopy." In review Nature Materials.
- (2) Mahoney MJ, Chen R, Saltzman WM, Neurite Growth in Microchannels of Different Width, Biomaterials, 26:771 (2005).
- (3) Mahoney MJ and Saltzman WM, Transplantation of brain cells assembled around a programmable, synthetic microenvironment. Nature Biotechnology, 19: 934-939 (2001).
- (4) Belcheva N, Woodrow-Mumford K, Mahoney MJ, and Saltzman WM. Synthesis and Biological Activity of Polyethylene Glycol-Mouse Nerve Growth Factor Conjugate. J. Bioconjugate Chemistry, 6, 932-937 (1999).
- (5) Mahoney MJ and Saltzman WM. Millimeter-scale positioning of a nerve-growth factor source and biological activity in the brain. Proceedings of the National Academy of Sciences, 96:4536-39 (1999).
- (6) Saltzman WM, Mak MW, Mahoney MJ, Duenas ET, and Cleland JL. Intracranial delivery of recombinant nerve growth factor: release kinetics and protein distribution from three delivery systems. Pharmaceutical Research, 16:232-240 (1999).
- (7) Mahoney MJ, Guo Y, Saloupis P, Shaw S, Stephano PA, and Rickman D, Bioactivity of BDNF released from microparticles: effect on neuronal cell architecture and engraftment in retinal tissue, in preparation for submission to Journal of Controlled Release.
- (8) Mahoney MJ, Anseth KS, Impact of Collagen types I on neural precursor cell

- survival, proliferation, and differentiation in three-dimensional PEG hydrogel culture, in preparation for submission to Biomaterials.
- (9) Mahoney MJ, Anseth KS, Polymer network chemistry influences the proliferation of encapsulated neural progenitor cells, in preparation for submission to PNAS.
- (10) Y. Guo, M.J. Mahoney, P. Saloupis, S. Shaw, and D. Rickman, "Co-transplantation of neural progenitor cells and sustained-release BDNF microspheres following light-induced photoreceptor degeneration." in review Journal of Neuroscience.

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, Biomedical Engineering Society

#### HONORS AND AWARDS

- 2005 University of Colorado, Junior Faculty Development Award
- 2003 Rita Schaffer Young Investigator Award, Biomedical Engineering Society
- 2001 Fellow (one of twelve total selected), Marine Biology Laboratory (Woods Hole, MA), Neurobiology Course
- 1999 Professor Demetrios Papahadjopoulos Award for Excellence in Graduate Studies in Drug Delivery
- 1996-1999 NASA Graduate Student Research Award

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Member, Animal Care and Use Committee, Boulder Campus 2004-2005

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

AIChE, BMES Meetings (presenting/attending research & educational sessions)  
Annually

## J. WILL MEDLIN, ASSISTANT PROFESSOR

Department of Chemical and Biological Engineering

University of Colorado

Boulder, CO 80309-0424

Phone: (303) 492-2418

Fax: (303) 492-4341

email: [will.medlin@colorado.edu](mailto:will.medlin@colorado.edu)

website: <http://www.colorado.edu/che/faculty/medlin>

### EDUCATION

Ph.D., Chemical Engineering, University of Delaware, 2001

B.S., Chemical Engineering, Clemson University, 1996

### PROFESSIONAL EXPERIENCE

University of Colorado, Boulder, CO (2003-present)

2003 – present: Assistant Professor, Department of Chemical Engineering

Postdoctoral Experience: Sandia National Laboratories, Livermore, CA (2001-2003)

### CONSULTING, PATENTS

1 pending (filed) U.S. Patent

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

- (1) Hyman, M. P. and J.W. Medlin, "Effect of Applied Electric Fields on Oxygen Dissociation on Pt(111)," J. Phys. Chem B (in press).
- (2) Medlin, J.W., R. Bastasz, A.H. McDaniel, "Hydrocarbon detection via ion implantation in metal-insulator-semiconductor devices," Applied Physics Letters 85 (22) 5457-5459 (2004).
- (3) Bastasz, R., J. W. Medlin, J. A. Whaley, R. Beikler, E. Taglauer, "Deuterium adsorption on W(100) studied by LEIS and DRS," Surface Science 571 (1-3), 31-40 (2004).
- (4) Medlin, J.W., A.E. Lutz, R. Bastasz, A.H. McDaniel, "The response of palladium metal-insulator-semiconductor devices to hydrogen-oxygen mixtures: Comparisons between kinetic models and experiment," Sensors and Actuators B 96 (1-2), 290-297 (2003).
- (5) Medlin, J.W., A.H. McDaniel, M.D. Allendorf, R. Bastasz, "Effects of competitive carbon monoxide adsorption on the hydrogen response of MIS sensors: The role of metal film morphology," Journal of Applied Physics, 93 (4), 2267-2274 (2003).
- (6) Medlin, J.W., M.D. Allendorf, "Theoretical study of the adsorption of acetylene on the (111) surfaces of Pd, Pt, Ni, and Rh," Journal of Physical Chemistry B, 107 (1), 217-223 (2003).
- (7) Linic, S., J.W. Medlin, M.A. Barteau, "Synthesis of oxametallacycles from iodoethanol on Ag(111) and the structure dependence of their reactivity," Langmuir, 18 (13), 5197-5204 (2002).
- (8) Medlin, J.W., M.A. Barteau, "The reaction of 1-chloro-2-methyl-2-propanol on oxygen-covered Ag(110): Epoxide formation via a surface chlorohydrin reaction," Surface Science, 506 (1-2), 105-118 (2002).
- (9) Medlin, J.W., J.R. Monnier, M.A. Barteau, "Deuterium kinetic isotope effects in butadiene epoxidation over unpromoted and Cs-promoted silver catalysts," Journal of Catalysis, 204 (1), 71-76 (2001).

- (10) Medlin, J.W., M.A. Barteau, "The formation of epoxides from reaction of oxametallacycles on Ag(110): A density functional theory study," Journal of Physical Chemistry B, 105 (41), 10054-10061 (2001).
- (11) Monnier, J.R., J.W. Medlin, M.A. Barteau, "Use of oxygen-18 to determine kinetics of butadiene epoxidation over Cs-promoted, Ag catalysts," Journal of Catalysis, 203 (2), 362-368 (2001).
- (12) Sherrill, A.B., J.W. Medlin, J.G. Chen, M.A. Barteau, "NEXAFS investigations of cyclooctatetraene on TiO<sub>2</sub>(001)," Surface Science, 492 (3), 203-213 (2001).
- (13) Ihm, H., J.W. Medlin, M.A. Barteau, J.M. White, "Thermal activation of *tert*-butyl nitrite on Pt(111): *tert*-butoxy dehydrogenation and oxametallacycle formation," Langmuir, 17 (3), 798-806 (2001).
- (14) Medlin, J.W., A.B. Sherrill, J.G. Chen, M.A. Barteau, "Experimental and theoretical probes of the structure of oxametallacycle intermediates derived from 1-epoxy-3-butene on Ag(110)," Journal of Physical Chemistry B, 105 (18) 3769-3775 (2001).

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, American Chemical Society, North American Catalysis Society

#### HONORS AND AWARDS

- 2005 Invited Speaker, China/USA/Japan Joint Chemical Engineering Conference, Beijing
- 2004 National Science Foundation CAREER Award
- 2004 Office of Naval Research Young Investigator Award
- 2004 Junior Faculty Development Award, University of Colorado
- 2001 Allan P. Colburn Prize for Outstanding Dissertation in the Mathematical Sciences and Engineering, University of Delaware
- 2000 AIChE Catalysis and Reaction Engineering Travel Award
- 2000 First Place, Philadelphia Catalysis Club Poster Competition
- 1999 Robert L. Pigford Teaching Assistant Award
- 1998 Garrett Reed Cantwell Graduate Scholarship
- 1997 National Science Foundation Graduate Fellowship
- 1996 Robert L. Pigford Graduate Fellowship
- 1996 Clemson University Faculty Scholarship Award

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

President, Western States Division of the North American Catalysis Society (2005-present); Program Chair for Surface Science, 2006 ACS Conference for Colloids and Catalysis (Boulder, CO); Omega Chi Epsilon Student Chapter Advisor (2004-present); Undergraduate Freshman Advisor (2004-present); Member, Graduate Committee (2004-present)

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

AIChE Meetings (presenting/attending research & educational sessions) Annually

## RICHARD D. NOBLE, PROFESSOR

Look Professor

Department of Chemical and Biological Engineering

University of Colorado, Boulder, CO 80309-0424

Phone: (303) 492-6100, Fax: (303) 492-4341

Email: [nobler@colorado.edu](mailto:nobler@colorado.edu),

website: <http://www.colorado.edu/che/faculty/noble.html>

### EDUCATION

Ph.D., Chemical Engineering, University of California, Davis, 1976

M.E., Chemical Engineering, Stevens Institute of Technology, 1969

B.E., Chemical Engineering, Stevens Institute of Technology, 1968

### PROFESSIONAL EXPERIENCE

Professor, Department of Chemical and Biological Engineering, University of Colorado  
9/90 - present

Co-Director, NSF I/UCRC Membrane Applied Science and Technology Center  
Research Professor, Department of Chemical and Biological Engineering, University of  
Colorado, 9/87-8/90

Associate Professor, Adjunct, Department of Chemical and Biological Engineering,  
University of Colorado, 4/83-9/87

Assistant Professor, Adjunct, Department of Chemical and Biological Engineering,  
University of Colorado, 8/81-4/83

Chemical Engineer, National Bureau of Standards, Boulder, CO, 5/81 - 9/87

Assistant Professor, Dept. of Chemical Engineering, University of Wyoming, 4/76-5/81

Design Engineer, National Starch and Chemical, Plainfield, NJ, 6/68 - 1/71

### CONSULTING, PATENTS

18 Issued U.S. Patents

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

195. Skoulidas, A.I.; Bowen, T.C.; Doelling, C.M.; Falconer, J.L.; Noble, R.D. and Sholl, D.S., "Comparing Atomistic Simulations and Experimental Measurements for  $CH_4/CF_4$  Mixture Permeation Through Silicalite Membranes," *Journal of Membrane Science* **227**, 123-136 (2003).
196. Gardner, T.Q.; Falconer, J.L. and Noble, R.D., "Characterization of ZSM-5 and ZSM-11 Zeolite Membranes by Transient Permeation of Butanes," *AIChE Journal* **50 (11)**, 2816-2834 (2004).
197. Scovazzo, P.; Camper, D.; Kieft, J. and Noble, R.D., "Regular Solution Theory and  $CO_2$ -Gas Solubility in Room Temperature Ionic Liquids," *Industrial and Engineering Chemistry Research* **43**, 6855-6860 (2004).
198. Scovazzo, P.; Kieft, J.; Finan, D.; Noble, R.D. and Koval, C.A., "Gas Separations Using Non-Hexafluorophosphate  $[PF_6]$  Anion Supported Ionic Liquid Membranes," *Journal of Membrane Science* **238**, 57-64 (2004).
199. Camper, D.; Scovazzo, P. and Noble, R.D., "Gas Solubilities in Room Temperature Ionic Liquids," *Industrial and Engineering Chemistry Research* **43 (12)**, 3049-3054 (2004).
200. Li, S.; Falconer, J.L. and Noble, R.D., "SAPO-34 Membranes for  $CO_2/CH_4$  Separations," *Journal of Membrane Science* **241**, 121-135 (2004).
201. Li, S.; Alvarado, G.; Noble, R.D. and Falconer, J.L., "Effect of Impurities on  $CO_2/CH_4$  Separation through SAPO-34 Membranes," *Journal of Membrane Science* **251**, 59-66 (2005).

202. Bowen, T.C.; Wyss, J.C.; Noble, R.D. and Falconer, J.L., "Inhibition during Multicomponent Diffusion through ZSM-5 Zeolite," *Industrial and Engineering Chemistry Research* **43**, 2598-2601 (2004).
203. Bowen, T.C.; Wyss, J.C.; Noble, R.D. and Falconer, J.L., "Measurements of Diffusion through a Zeolite Membrane using Isotopic-Transient Pervaporation," *Microporous and Mesoporous Materials* **71**, 199-210 (2004).
204. Bowen, T.C.; Noble, R.D. and Falconer, J.L., "Fundamentals and Applications of Pervaporation through Zeolite Membranes," *Journal of Membrane Science* **245**, 1-33 (2004).
205. Shah, M.R.; Noble, R.D. and Clough, D.E., "Pervaporation-Air Stripping Hybrid Process for the Removal of VOCs from Groundwater," *Journal of Membrane Science* **241**, 257-263 (2004).
206. Norman, M.; Noble, R.D. and Koval, C.A., "Electrochemical Pumping of DMF Electrolyte Solutions Across Membranes," *Journal of the Electrochemical Society* **151 (12)**, E364-E369, 2004.

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

AIChE, ACS, NAMS, ASEE

#### HONORS AND AWARDS

ASEE Dow Outstanding Young Faculty Award, Rocky Mountain Section, 1981  
 ASEE AT&T Foundation Award, Rocky Mountain Section, 1985  
 Outstanding Undergraduate Professor Award, Chemical Engineering Dept. (1993)  
 ACS Colorado Section Award, 1994  
 Univ. of Colorado Bank One Colorado Corporation 1994-95 Faculty Community Service Award  
 College of Engineering Outstanding Research Award, 1995  
 Outstanding Undergraduate Professor Award, Chemical Engineering Dept. (1995)  
 University of Colorado Faculty Council Award for Excellence, 1995  
 Japan Industrial Technology Association Foreign Researcher Fellowship, 1996  
 Max S. Peters Faculty Service Award, College of Engineering, 1998  
 Boulder Faculty Assembly Excellence in Service Award, 1999  
 Outstanding Undergraduate Professor Award, Chemical Engineering Dept. (1999)  
 Boulder Faculty Assembly Excellence in Research Award, 2001  
 Elected Fellow of AIChE, 2001  
 Fulbright Senior Specialist Grant, 2003  
 Outstanding Graduate Teaching Award, Chemical Engineering Dept. (2003)  
 UC Davis Distinguished Engineering Alumni Award (2003)  
 CU Residence Life Teaching Award (2004)

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Separation Science and Technology, Editorial Board, 1997-present; Editor, Separation and Purification Methods, 1998-; Gordon Conference on Membranes: Materials and Processes, Vice Chairman, 1997, Chairman, 2000; Advisory Board, Membrane Products Corporation, 1998; Journal of Membrane Science, Editorial Board, 1999-; Separation and Purification Technology, Editorial Board, 2000-; Third International Zeolite Membrane Meeting, Chair, 2004; International Congress on Inorganic Membranes, Co-Chair, 2004; Separation and Purification Reviews, Editorial Board, 2004-

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

Attend numerous national and international meetings (presenting/attending research and educational sessions) annually

**W. FRED RAMIREZ, PROFESSOR**  
Department of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 492-8660  
Fax: (303) 492-4341  
email: [fred.ramirez@colorado.edu](mailto:fred.ramirez@colorado.edu)  
website: <http://www.colorado.edu/che/faculty/ramirez.html>

#### EDUCATION

Ph.D., Tulane University, August 1965  
M.S., Tulane University, August 1964  
B.S., Tulane University, May 1962

#### PROFESSIONAL EXPERIENCE

Professor, Department of Chemical Engineering, University of Colorado, 1975-present  
Chair, Department of Chemical Engineering, University of Colorado, 1971-1979, 1989-1992, 1997-1998  
Associate Professor, Department of Chemical Engineering, University of Colorado, 1970-1975  
Assistant Professor, Department of Chemical Engineering, University of Colorado, 1965-1970  
Industrial Fellow, Marathon Oil Co., Denver, Colorado, Summer 1968  
Research Engineer, E. I. DuPont de Nemours, Seaford, Delaware, Summer 1964  
Development Engineer, E. I. DuPont de Nemours, Richmond, Virginia, Summer 1963  
Bioengineering Research, U.S.V.A. Hospital, New Orleans, Louisiana, Summer 1962

#### CONSULTING

Regular Consultant; Denver Research Center, Marathon Oil Company, 1968-1976;  
Dowell Division Dow Chemical, 1980-1985; Adolph Coors Company, 1988-89.  
Have also consulted for Dow Chemical Company (1968), Johnson and Johnson, Inc. (1970), University of Colorado Medical School (1967), Cobe Laboratory (1969), Monsanto (1970, 1971), Colorado Water Quality Commission (1978), Dowell (1977-85), Chevron Oil Field Research (1978-80), Klemick & Assoc. (1979), Gary Operating (1979), Upjohn (1980), Affimetrix (1998).

#### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

1. Lu, S. X., Ramirez, W. F., and Anseth, K. S., "Photopolymerized, Multilaminated Matrix Devices with Optimized Nonuniform Initial Concentration Profiles to Control Drug Release," *J. Pharm. Sci.* **89**, 45-51 (2000).
2. Klein, E. J. and Ramirez, W. F., "Consideration of Local Shadowing and Ion Beam Voltage Effects in the Prediction of a Surface Evolving Under Ion Milling," *J. Vacuum Sci. & Tech. A* **18**, 166-175 (2000).
3. Tholudur, A., Ramirez, W. F., and McMillan, J. D., "Interpolated Parameter Functions for Neural Network Models," *Computers and Chemical Engineering* **24**, 2545-2553 (2000).
4. Narayan, A. P. and Ramirez, W. F., "Fault Diagnosis for Air Contamination Events in Three-dimensional Environments," *Int. J. Control* **73**, 1592-1604 (2000).
5. Klein, E. J. and Ramirez, W. F., "State Controllability and Optimal Regulator Control of Time-delayed Systems," *Int. J. Control* **74**, 281-289 (2001).

### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute for Chemical Engineers, American Chemical Society, American Society for Engineering Educators, Society for Petroleum Engineers

### HONORS AND AWARDS

- 1997 Boulder Faculty Assembly Outstanding Research Award
- 1992-93 Faculty Fellowship from the University of Colorado
- 1991 Outstanding Alumnus Award-Tulane University College of Engineering
- 1990 Fellow-American Institute of Chemical Engineers
- 1988 Max S. Peters Service Award of University of Colorado College of Engineering
- 1987 Academy of Science Exchange Fellow to the Soviet Union, September-December
- 1986 University of Colorado College of Engineering Faculty Research Award
- 1985-86 Faculty Fellowship from the University of Colorado
- 1980 ASEE Western Electric Award for Excellence in Engineering Education
- 1980 Croft Research Professorship
- 1976 Fulbright-Hays Research Fellowship to France
- 1974 Harold A. Levey Award for outstanding achievement within 10 years of graduation by a Tulane University Engineering graduate
- 1974 ASEE Dow Outstanding Young Faculty Award

Theodore W. Randolph, PROFESSOR  
Department of Chemical and Biological Engineering, University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 492-4776  
Fax: (303) 492-4341  
email: [Theodore.Randolph@colorado.edu](mailto:Theodore.Randolph@colorado.edu)

#### EDUCATION

Ph.D., University of California, Berkeley, 1980  
B.S., Chemical Engineering, University of Colorado, 1983

#### PROFESSIONAL EXPERIENCE

1999: Professor, Dept. of Chemical Engineering, University of Colorado, Boulder  
1997: Co-Director, University of Colorado Center for Pharmaceutical Biotechnology  
1993: Patten Assoc. Professor, Dept. of Chemical Engineering, University of Colorado, Boulder  
1993: Associate Professor, Department of Chemical Engineering, Yale University  
1989-1992: Assistant Professor, Department of Chemical Engineering, Yale University  
1987- 1989: Collaborateur Scientifique, Swiss Federal Institute of Technology, Lausanne, Switzerland.

#### CONSULTING, PATENTS

9 Issued U.S. Patents; 4 pending (filed) U.S. and International Patents; Co-founded RxKinetix, Inc., and BaroFold, Inc., consulting arrangements with >15 companies last 5 years

#### SAMPLE PUBLICATIONS LAST 2 YEARS (out of 19)

1. Chi, EY, Weickmann, J, Carpenter, JF, Manning, MC, Randolph, TW, (2004) "Heterogeneous Nucleation-Controlled Particulate Formation of Recombinant Human Platelet-Activating Factor Acetylhydrolase in Pharmaceutical Formulation," *Journal of Pharmaceutical Sciences* 94(2), 256-274.
2. Jarmer DJ, Lengsfeld CS, Randolph TW (2004), "Nucleation and growth rates of poly(L-lactic acid) microparticles during precipitation with a compressed-fluid antisolvent", *Langmuir* 20 (17): 7254-7264
3. Stoner MR, Fischer N, Nixon L, Buckel S, Benke M, Austin F, Randolph TW, Kendrick BS (2004), "Protein-solute interactions affect the outcome of ultrafiltration/diafiltration operations" *Journal of Pharmaceutical Sciences* 93 (9): 2332-2342
4. Seefeldt MB, Ouyang J, Froland WA, Carpenter JF, Randolph TW, (2004), "High-pressure refolding of bikunin: Efficacy and thermodynamics" *Protein Science* 13 (10): 2639-2650
5. Patel MM, Zeles MG, Manning MC, Randolph TW, Anchordoquy TJ (2004) "Degradation kinetics of high molecular weight poly (L-lactide) microspheres and release mechanism of lipid : DNA complexes", *Journal of Pharmaceutical Sciences* 93 (10): 2573-2584.
6. Jarmer, DJ, Lengsfeld, CS, and Randolph, TW, (2003) "Manipulation of particle size distribution of poly(L-lactic acid) nanoparticles with a jet-swirl nozzle during precipitation with a compressed antisolvent," *J. Supercritical Fluid* 27(3), 317-336.

7. Biggs, DL, Lengsfeld, CS, Hybertson, BM, Ng, K-Y, Manning, MC, and Randolph, TW, (2003) "In vitro and in vivo evaluation of the effects of PLA microparticle crystallinity on cellular response" *J. Controlled Release*, 92, 147-161.
8. Chi EY, Krishnan S, Kendrick BS, Chang BS, Carpenter JF, Randolph TW (2003) "Roles of conformational stability and colloidal stability in the aggregation of recombinant human granulocyte colony-stimulating factor" *Protein Science* 12 (5): 903-913.
9. Kim, Y.-S., Randolph, T.W., Manning, M.C., Stevens, F.J. and Carpenter, J.F, (2003) "Congo red populates partially unfolded states of an amyloidogenic protein to enhance aggregation and amyloid fibril formation," *J. Biol. Chem.* 278 (12): 10842-10850
10. Krishnan, S., Chi, E.Y., Wood, S.J., Kendrick, B.S., Li, C., Garzon-Rodriguez, W., Wypych, J., Randolph, T.W., Narhi, L., Biere, A.L., Citron, M., and Carpenter, J.F., (2003) "Oxidative Dimer Formation is the Critical Rate-Limiting Step for Parkinson's Disease  $\alpha$ -Synuclein Fibrillogenesis," *Biochemistry*, 2 (3): 829-837.
11. Kim YS, Jones LS, Dong AC, Kendrick BS, Chang BS, Manning MC, Randolph TW, Carpenter JF (2003) "Effects of sucrose on conformational equilibria and fluctuations within the native-state ensemble of proteins," *Protein Science*, 12(6), 1252-1261.

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, American Association of Pharmaceutical Scientists, American Chemical Society

#### HONORS AND AWARDS

Boulder Faculty Assembly Research and Creative Work Award; College of Engineering and Applied Sciences Max Peters Award for Outstanding Service; Outstanding Graduate Teaching Award, Department of Chemical Engineering, 2000; Faculty Fellowship, University of Colorado, Boulder 1999-2000; College of Engineering and Applied Sciences Outstanding Research and Service Award, 1998; Invited Foreign Researcher, Japanese Agency of Industrial Science and Technology, 1995; Patten Associate Professor Chair in Chemical Engineering, University of Colorado, Boulder, 1993; John J. Lee Junior Professorship Chair in Chemical Engineering, Yale University, 1993; Senior Faculty Fellowship, Yale University, 1993; National Science Foundation Presidential Young Investigator Award, 1991

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Editorial Board Member, *Journal of Pharmaceutical Sciences*; Editorial Board Member, *Current Pharmaceutical Biotechnology*; Co-director, Medical and Scientific Advisory Board, RxKinetix, Inc.; Member, Scientific Advisory Board, AktivDry, Inc.; Member, Scientific Advisory Board, Integrated Biosystems, Inc.; Member, Board of Directors, University Technology Corporation; Founder and Scientific Advisory Board Director, BaroFold, Inc.; Director, NIH Leadership Training Program in Pharmaceutical Biotechnology.; Chair, Biomedical Engineering Committee; Chair, Faculty Inventor's Council; Member, University Committee on Intellectual Property;

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

AIChE, AAPS, and ACS Meetings (presenting/attending research sessions) Annually

ROBERT SANI, PROFESSOR  
Department of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 492-5517  
Email: sani@colorado.edu

#### EDUCATION

B.S., University of California at Berkeley, 1958  
M.S., University of California at Berkeley, 1960  
Ph.D., University of Minnesota, 1963

#### PROFESSIONAL EXPERIENCE

September 1976-present, Professor of Chemical Engineering, University of Colorado  
February 1983 - June 1983, Visiting Research Associate, University of Minnesota, Minneapolis, Minnesota  
September 1982-January 1983, Professeur Associ., l'Universit, d'Aix-Marseille I, Marseille, France  
June 1979-June 1980, Acting Director, Cooperative Institute for Research in Environmental Sciences, University of Colorado  
Summer 1974-1983, Lawrence Livermore National Laboratory, Physics Department, Atmospheric Science Division  
1970-1971, Visiting Associate in Chemical Engineering, California Institute of Technology  
1970-1976, Associate Professor of Chemical Engineering, University of Illinois  
Summer 1970, American Oil Company; research on hybrid computing methods  
Summer 1964, University of Minnesota; research position in the Department of Chemical Engineering  
1963 and spring Semester 1964, Rensselaer Polytechnic Institute; teaching and research position in Department of Mathematics  
September 1964-1970, Assistant Professor of Chemical Engineering, University of Illinois  
Summer 1958, Western Regional Research Laboratory, U.S.D.A.; research on boiling heat transfer  
Summer 1959, Research Assistant, Lawrence Radiation Laboratory

#### CONSULTING

Lawrence Livermore National Laboratory (1976-1990)  
Fluid Dynamics International (1986-1996)

#### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

1. Gresho, P.M. and Sani, R.L., *Incompressible Flow and the Finite Element Method, Vol 1.and Vol. 2*, John Wiley and Sons, Ltd. (2000).
2. Li, D., Sani, R.L., Greenberg, A.R. and Krantz, W.B., "Studies of the Thermally Induced Phase Separation (TIPS) Membrane Formation Process," Proc. China-US AIChE Meeting, Beijing, September (2000).
3. Georgiadou, M., Veyret, D., Sani, R.L. and Alkire, R.C., "Simulation of Shape Evolution During Electrodeposition of Copper in the Presence of Additive," *J. Electrochemical Soc.*, [148], 54-58, (2001).
4. Sani, R.L., "Modeling Electrochemical Systems," Proc. 10<sup>th</sup> International Colloquium on Numerical Analysis and Computer Sciences, Plovdiv, Bulgaria (2001).

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers  
Tau Beta Pi

HONORS AND AWARDS

Guggenheim Fellowship, 1970-71

Listed in: Who's Who in Technology Today

Men of Achievement

Who's Who in Frontier Science and Technology

Who's Who in America

Who's Who in Society

International Leaders in Achievement

International Who's Who in Engineering

Faculty Research Award, College of Engineering and Applied Sciences,  
University of Colorado, 1983

INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Editorial Board, International Journal for Numerical Methods in Fluids

Editorial Board, Revue Europeenne des Elements Finis

Editorial Board, Int'l. J. Computational Engineering Science

Editorial Board, Int'l. J. Computational and Numerical Analysis and Applications

PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

Technical meetings

Ecole d'Ete, Marseille, France (2000,2002)

DANIEL K. SCHWARTZ, PROFESSOR  
Department of Chemical and Biological Engineering  
University of Colorado  
Boulder, CO 80309-0424  
Phone: (303) 735-0240  
email: [daniel.schwartz@colorado.edu](mailto:daniel.schwartz@colorado.edu)

#### EDUCATION

Ph.D., Physics, Harvard University, 1991  
A.B., Chemistry and Physics, Harvard University, 1984

#### PROFESSIONAL EXPERIENCE

University of Colorado, Boulder, CO  
2004 – present: Professor, Department of Chemical and Biological Engineering  
2001 – 2004: Associate Professor, Department of Chemical and Biological Engineering  
Tulane University, New Orleans, LA  
1998 – 2001: Associate Professor, Department of Chemistry  
1994 – 1998: Assistant Professor, Department of Chemistry

#### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS

1. J.T. Woodward, H. Gwin, and D.K. Schwartz, "Contact angles on surfaces with mesoscopic chemical heterogeneity" *Langmuir*, **16**, 2957-2961 (2000)
2. J. Iñes-Mullol and D.K. Schwartz, "Alignment of Hexatic Langmuir Monolayers under Shear" *Phys. Rev. Lett.* **85**, 1476 (2000).
3. A.T. Ivanova and D.K. Schwartz, "Transient Behavior of the Velocity Profile in Channel Flow of a Langmuir Monolayer" *Langmuir* **16**, 9433-9438 (2000).
4. Doudevski and D.K. Schwartz, "Evolution of a Steady State Island Size Distribution during Self-Assembled Monolayer Dissolution" *J. Phys. Chem. B* **104**, 9044-9047 (2000).
5. Doudevski and D.K. Schwartz, "Mechanisms of Self-Assembled Monolayer Desorption Determined using In Situ Atomic Force Microscopy" *Langmuir* **16**, 9381-9384 (2000).
6. R.M. Enmon Jr., K.C. O'Connor, D.J. Lacks, D.K. Schwartz, and R.S. Dotson, "Dynamics of Spheroid Self-Assembly in Liquid-Overlay Culture of DU 145 Human Prostate Cancer Cells" *Biotechnol. Bioeng.*, **72**, 579-591 (2001).
7. C. Messerschmidt and D.K. Schwartz, "Growth mechanisms of octadecylphosphonic acid self-assembled monolayers on sapphire (corundum): Evidence for a quasi-equilibrium triple point" *Langmuir* **17**, 462-467 (2001).
8. D.K. Schwartz, "Mechanisms and Kinetics of Self-Assembled Monolayer Formation" *Ann. Rev. Phys. Chem.* **52**, 107-137 (2001).
9. B.K. Simmons, C. Taylor, S. Li, F. Landis, V.T. John, G.L. McPherson, D.K. Schwartz and R. Moore, "Microstructure Determination of AOT + Phenol Organogels Utilizing Small-Angle X-Ray Scattering and Atomic Force Microscopy" *J. Am. Chem. Soc.* **123**, 2414-2421 (2001)
10. J. Iñes-Mullol and D.K. Schwartz, "Shear-induced Molecular Precession in a Hexatic Langmuir Monolayer." *Nature* **410**, 348-351 (2001).
11. Doudevski and D.K. Schwartz, "Concentration dependence of self-assembled monolayer island nucleation and growth." *J. Am. Chem. Soc.* **123**, 6867-6872 (2001).

12. A.T. Ivanova, J. Iñes-Mullol, and D.K. Schwartz, "Micro-rheology of a sheared Langmuir monolayer: Elastic recovery and inter-domain slippage." *Langmuir* **17**, 3406-3411 (2001).
13. J. Iñes-Mullol and D.K. Schwartz, "Molecular Orientation in Langmuir Monolayers under Shear." *Langmuir* **17**, 3017-3029 (2001).
14. D.Y. TAKAMOTO, E. AYDIL, J.A. ZASADZINSKI, A. T. IVANOVA, D.K. SCHWARTZ, T. YANG, P.S. CREMER, "STABLE ORDERING IN LANGMUIR-BLODGETT FILMS" *SCIENCE* **293**, 1292-1295 (2001).
15. J. Ding, H.E. Warriner, J.A. Zasadzinski, D.K. Schwartz, "A Magnetic Needle Viscometer For Langmuir Monolayers" *Langmuir* **18**, 2800-2806 (2002).
16. R.M. Enmon Jr., K.C.O 'Connor, H. Song, D.J. Lacks, D.K. Schwartz, "Aggregation Kinetics of Well and Poorly Differentiated Human Prostate Cancer Cells" *Biotechnol. Bioeng.* **80**, 580-588 (2002).
17. B.M. Ocko, M. Kelly, A.T. Nikova, D.K. Schwartz, "Structure and phase behavior of mixed monolayers of saturated and unsaturated fatty acids" *Langmuir* **18**, 9810-9815 (2002).
18. B. Simmons, S. Li, V.T. John, G.L. McPherson, C. Taylor, D.K. Schwartz and K. Maskos, "Spatial compartmentalization of nanoparticles into strands of a self-assembled organogel". *Nanoletters* **2**, 1037-1042 (2002).
19. G.B. Bantchev and D.K. Schwartz "Surface rheology of  $\beta$ -casein layers at the air/solution interface: Formation of a two-dimensional physical gel" *Langmuir* **19**, 2673-2682 (2003).
20. C.E. Taylor and D.K. Schwartz, "Octadecanoic acid self-assembled monolayer growth at sapphire surfaces" *Langmuir* **19**, 2665-2672 (2003).
21. J.M. Mellott, W.A. Hayes, and D.K. Schwartz, "Kinetics of Octadecyltrimethylammonium Bromide Self-Assembled Monolayer Growth at Mica from Aqueous Solution" *Langmuir* **20**, 2341-2348 (2004).
22. J.M. Mellott and D.K. Schwartz, "Supercritical Self-Assembled Monolayer Growth" *J. Am. Chem. Soc.*, **126**, 9369-9373 (2004)
23. G.B. Bantchev and D.K. Schwartz, "Structure of  $\beta$ -casein layers at the air/solution interface: Atomic Force Microscopy studies of transferred layers." *Langmuir*, **20**, 11692-11697 (2004)

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, American Chemical Society

#### HONORS AND AWARDS

1999	Camille Dreyfus Teacher-Scholar Award
1998	NSF/CAREER Award
1997-1999	Mortarboard Honor Society Salute for Excellence in Teaching (3 times)
1994	Camille & Henry Dreyfus Foundation New Faculty Award
1985-1986	Stone and Webster Fellowship, Harvard University
1983	Phi Beta Kappa, Harvard University
1981-1984	John Harvard Scholarship, Harvard University
1981	Detur Prize (outstanding freshmen award), Harvard University

#### INSTITUTIONAL AND PROFESSIONAL SERVICE

Senior Editor, *Langmuir*

Director, NSF-REU Site Program in Functional Materials

## ALAN W. WEIMER, PROFESSOR

Department of Chemical and Biological Engineering

University of Colorado

Boulder, CO 80309-0424

Phone: (303) 492-7471 or -3759

Fax: (303) 492-4341

email: [alan.weimer@colorado.edu](mailto:alan.weimer@colorado.edu)

website: <http://www.colorado.edu/che/TeamWeimer/index.htm>

### EDUCATION

Ph.D., Chemical Engineering, University of Colorado, 1980

M.S., Chemical Engineering, University of Colorado, 1978

B.S., Chemical Engineering, University of Cincinnati, 1976

### PROFESSIONAL EXPERIENCE

University of Colorado, Boulder, CO (1996-present)

1996 – present: Professor, Department of Chemical and Biological Engineering

Industrial Experience: The Dow Chemical Company, Midland, MI (1980-1996)

### CONSULTING, PATENTS

20 Issued U.S. Patents; 8 pending (filed) U.S. Patents; Co-founded ALD NanoSolutions, Inc.

### PROFESSIONAL LICENSING

Licensed PE – State of Colorado (#20279)

### PRINCIPAL PUBLICATIONS OF LAST FIVE YEARS (2004-2005 only)

- (1) Ferguson, J.D., A.W. Weimer, and S.M. George, "Surface Chemistry and Infrared Absorbance Changes during ZnO Atomic Layer Deposition on ZrO<sub>2</sub> and BaTiO<sub>3</sub> Particles," Journal of Vacuum Science and Technology, 23 (1), 118-125 (2005).
- (2) Dahl, J.K., A.W. Weimer, A. Z'Graggen, and A. Steinfeld, "Two-dimensional Ax-symmetric Model of a Solar-thermal Fluid-wall Aerosol Flow Reactor," Journal of Solar Energy Engineering, 127, 76-85 (2005).
- (3) Ferguson, J.D., A.W. Weimer, and S.M. George, "Atomic layer Deposition of Al<sub>2</sub>O<sub>3</sub> Films on Polyethylene Particles," Chemistry of Materials, 16 (26), 5602-5609 (2004).
- (4) Perkins, C. and A.W. Weimer, "Likely Near Term Solar-thermal Water Splitting Technologies," International Journal of Hydrogen Energy, 29 (15), 1587-1599 (2004).
- (5) Ferguson, J.D., E.R. Smith, A.W. Weimer, and S.M. George, "Atomic Layer Deposition of SiO<sub>2</sub> at Room Temperature using TEOS and H<sub>2</sub>O with NH<sub>3</sub> as the Catalyst," J. Electrochemical Society, 151 (8), G528-G535 (2004).
- (6) Dahl, J.K., A.W. Weimer, A. Lewandowski, C. Bingham, F. Bruetsch, and A. Steinfeld, "Dry Reforming of Methane Using a Solar-thermal Aerosol Flow Reactor," Industrial and Engineering Chemistry Research, 43 (18), 5489-5494 (2004).
- (7) Ferguson, J.D., A.R. Yoder, A.W. Weimer, and S.M. George, "TiO<sub>2</sub> Atomic Layer Deposition on ZrO<sub>2</sub> Particles Using Alternating Exposures of TiCl<sub>4</sub> and H<sub>2</sub>O," Applied Surface Science, 226 (4), 393-404 (2004).
- (8) Wank, J.R., George, S.M., and A.W. Weimer, "Nanocoating Individual Cohesive Boron Nitride Particles in a Fluidized Bed by ALD," Powder Technology, 142 (1), 59-69(2004).

- (9) Wank, J.R., K.J. Buechler, L. Hakim, S.M. George, and A.W. Weimer, "Coating Fine Iron Particles with an Oxidation-Resistance  $\gamma$ -Alumina Nanolayer Using ALD in a Fluidized Bed Reactor," in Fluidization XI - Present and Future of Fluidization Engineering, ECI International (Brooklyn, NY) (U. Arena, R. Chirone, M. Miccio, and P. Salatino, editors), 603-610 (2004).
- (10) Dahl, J.K., K.J. Buechler, A.W. Weimer, A. Lewandowski, and C. Bingham, "Solar-thermal Dissociation of Methane in a Fluid-wall Aerosol Flow Reactor," International Journal of Hydrogen Energy, 29 (7), 725-736 (2004).
- (11) Wank, J.R., S.M. George, and A.W. Weimer, "Coating Fine Nickel Particles with  $Al_2O_3$  Utilizing an Atomic Layer Deposition Fluidized Bed Reactor (ALD-FBR)," J. Amer. Ceram. Soc., 87 (4), 762-765 (2004).
- (12) Dahl, J.K. W.B. Krantz, and A.W. Weimer, "Sensitivity Analysis of the Rapid Decomposition of Methane in an Aerosol Flow Reactor," Int. Journal of Hydrogen Energy, 29 (1), 57-65 (2004).
- (13) Dahl, J.K., K.J. Buechler, R. Finley, T. Stanislaus, A.W. Weimer, A. Lewandowski, C. Bingham, A. Smeets, and A. Schneider, "Rapid Solar-thermal Dissociation of Natural Gas in an Aerosol Flow Reactor," Energy, 29 (5-6), 715-725 (2004).

#### SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Institute of Chemical Engineers, American Ceramics Society, American Chemical Society, American Solar Energy Society

#### HONORS AND AWARDS

2005 University of Colorado at Boulder Research Award  
 2004 University of Colorado at Boulder Inventor of the Year Award  
 2004 R&D 100<sup>TM</sup> Award  
 2004 Fellow of the AIChE  
 2004 Keynote Address (PARTEC2004, Nuremberg, Germany)  
 1997 AIChE Particle Technology Forum *Fluidized Process Recognition Award*  
 1995 Dow Chemical Company *Excellence in Science Award*  
 1993 Dow Chemical Company Research *Inventor of the Year Award*  
 1993 Mid-Michigan AIChE *Professional Progress Award*  
 1991 *Distinguished Young Engineering Alumnus Award* (University of Cincinnati)  
 1990 Dow Chemical Company *Spangenberg Ceramics Founder's Award*

#### INSTITUTIONAL AND PROFESSIONAL SERVICE IN THE LAST FIVE YEARS

Editorial Board – Powder Technology (Elsevier); Chair, AIChE Particle Technology Forum, 2004- present; Vice Chair 2002-2004; Treasurer, 2000-2002; Chair, Council on Research and Creative Work (CRCW), Boulder Campus, 2004; AIChE U/G Student Chapter Advisor (1996-2001; 2003-present); ABET Chairman (2000-present); Undergraduate Sophomore and Materials Option Advisor 1997-2003; Co-operative Education Chairman (2000-2004)

#### PROFESSIONAL DEVELOPMENT ACTIVITIES IN THE LAST FIVE YEARS

AIChE Meetings (presenting/attending research & educational sessions) Annually

