Responsive and Programmable Materials Group
Principal Investigator: Prof. Tim White
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**R+PM Group – Approach to Research**

**Keywords:** polymers, liquid crystals, soft materials, shape memory, stimuli-responsive, nanomaterials, photonics, robotics.

Research in the R+PM group is generally focused on soft materials, specifically polymers, liquid crystals, and nanomaterials. Applications of our research are far-ranging, from national security (aerospace materials) to energy (smart windows).

With the move to CU, our group is looking to expand research to explore emerging opportunities in the health sciences and robotics.

Research in the R+PM Group sits at the interface of chemical engineering, materials science, optics, mechanics, and device engineering.

**Prior Research in R+PM Group**

**Vision:** exploiting directed self-assembly of liquid crystalline polymer networks and elastomers to realize distinctive functional utility.

Our research focus is to prepare materials that are “programmed” for functional response and adaptation when triggered by a stimulus. What does this mean? Figure 1 is illustrative. In this example, we took the famous picture of Ansel Adams, “The Tetons and the Snake River”, developed optical patterning methods to organize liquid crystalline compositions, that upon polymerization retain this organization to form a “pixelated” polymer. The local orientation of the material in each of the pixels determines the optical performance.

**Programmable Actuators – Enabling Function in Robotics, Energy, and Medicine**

- Shape change triggered by a stimuli
- Leverage optical patterning methods to organize liquid crystalline polymer networks and elastomers with arbitrarily complex orientation
- Develop materials responsive to light, electrical field, or heat
- 20 kg of output force, nearly 3,000 time their weight

**Next Generation Optics**

- Stimuli-induced reconfiguration of optical properties in cholesteric liquid crystal phase
- Potential applications: electrochromic windows and mirrors

**Life in the R+PM Group**

**1st Year Research in the R+PM Group**

- **Patterning deformation in elastomeric materials of homogeneous composition**
  - Goal: ruggedized devices by using “hard” regions to protect sensitive components
  - My work: Hayden Fowler

**Potential Research Projects for Fall 2019**

- **Electromechanical actuation in LCEs**
  - Realization of electric field control of shape in liquid crystalline elastomers
  - Project will bridge materials chemistry, integration of conductive electrodes, mechanical characterization, and performance assessment

- **Mechanochemistry with LCEs**
  - Synthesize and perform responsive LCEs with conductive and responsive LCEs to realize all-optical control of permanent shapes.

**3-D printing**

- 3-D print with direct ink write, preparation of responsive element and robots.

**Optical materials**

- Develop IR-transparent, photosensitive polymerizable composites amenable to 3-D printing.

**About the PI**

Professor White joined the faculty at the University of Colorado in July of 2018. Tim received his Ph.D. in Chemical and Biochemical Engineering in 2006 from the University of Iowa. Subsequently, he joined the Air Force Research Laboratory where he eventually served as a Senior Research Engineer and Technology Advisor of the Photonic Materials Branch in the Materials and Manufacturing Directorate. In this capacity, Dr. White led a large interdisciplinary team undertaking basic, applied, and developmental research projects. In July of 2018, Tim was appointed as the first Galgally Professor of Engineering at the University of Colorado Boulder and founded the “Responsive and Programmable Materials” Group.

Tim has published nearly 140 papers in peer-reviewed journals including publications in Science, Nature, and Nature Materials. Tim has been honored with the 2016 Materials Research Society “Outstanding Young Investigator” award, the 2013 SPIE Early Career Achievement award, the 2013 American Chemical Society PMSE Division Award for “Cooperative Research in Applied Polymer Science”, and the 2012 Air Force Early Career Award.

Dr. White has been active in the materials research community in leadership activities with American Chemical Society (POLY), Materials Research Society, and SPIE.

**R+PM Group – Training Philosophy**

The R+PM Group primarily exists to facilitate the development of graduate students into independent scientists and engineers. As PI, Tim is a proactive mentor, seeking to:

- Identify and define project goals and milestones to enable early success
- Equip personnel with appropriate training, expertise, and world-class equipment to initiate and complete impactful research
- Through individual mentoring and R+PM Group culture, model the art of functional materials research
- Continuous emphasis on communication skill development and refinement
- Maturation of scientific expertise
- Facilitate autonomy
- Transition from mentee to mentor

Success in the R+PM Group is defined as:

- Mastery (as a researcher; as a communicator; as a teammate)
- Productivity (impactful research disseminated in journals and national/international conferences)
- Personal and professional fulfillment

**Website and Social Media**

Web: [https://www.colorado.edu/research/rpmgroup/](https://www.colorado.edu/research/rpmgroup/)

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