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University of Colorado Boulder
Department of Mechanical Engineering
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RESEARCH INTERESTS

Elastic Wave Propagation, Ultrasonic Imaging, Materials Process Monitoring and Control, Biomedical Optics, Optical Sensors, Nanoscale Materials Characterization, Optical Techniques for Nondestructive Evaluation, Nanoelectromechanical Systems, Laser Ultrasonics, Photorefractive Materials and Devices.

EDUCATION

Johns Hopkins University **Baltimore, MD**
Ph.D. Materials Science and Engineering, 1998
M.S.E. Materials Science and Engineering, 1994
B.S. Biomedical Engineering, 1992

EXPERIENCE

Department of Mechanical Engineering **Boulder, CO**
University of Colorado Boulder
Associate Professor (tenured), September, 2009-
Director: Imaging Science IRT, 2018-
Associate Chair, Mechanical Engineering, 2013-2015
Director: Laser Acoustics Lab

Research Center for Nondestructive Testing **Linz, Austria**
RECENDT
Visiting Research Scientist, September, 2015- January, 2016

Department of Mechanical Engineering **Boston, MA**
Boston University
Associate Professor (tenured), September, 2007- 2009
Assistant Professor, August, 2001-August, 2007

National Institute of Standards and Technology (NIST) **Boulder, CO**
Materials Reliability Division
Visiting Research Scientist, September, 2007- September 2008

Department of Mechanical Engineering **Evanston, IL**
Northwestern University
Research Assistant Professor, September 2000 - July 2001
Research Associate, 1999-2000
Postdoctoral Research Fellow, 1998-1999
Appointments under Dr. Jan Achenbach and Dr. Sridhar Krishnaswamy

Department of Materials Science and Engineering **Baltimore, MD**
Johns Hopkins University
Graduate Student/ Research Assistant, Fall 1992-Spring 1998
Advisor: Dr. James Wagner

AWARDS/ SYNERGISTIC ACTIVITIES

- Mechanical Engineering Outstanding Undergraduate Educator Award (2015).
- IPPA (International Photoacoustic and Photothermal Association) Junior Research Award (2009) for “outstanding contributions to high sensitivity ultrasonically based inspection techniques, applications to the mechanical characterization of thin films, plates, and membranes, functionally graded coatings, and micro- and nanoelectromechanical systems; development of laser array approaches for the optical generation and detection of elastic waves; and development of a novel photorefractive crystal based technique to detect ultrasound modulated light in diffuse media.”
- NSF *CAREER* Award Recipient (2005).
- Recipient of a Boston University *Technology Development Award* (2004).
- Recipient of a *Special Service Citation* from the AIAA for “superbly planning, organizing, and assisting with the hosting of the 2004 Region I Northeast Student Conference” (2004).
- Recipient of a University of Colorado *Innovative Seed Grant Award* (2012).
- Recipient of a Boston University College of Engineering Certificate of Appreciation (through the Class of 2006 Gift Program for making a positive impact on the life of a student).
- Recipient of a Boston University *SPRInG Award* (2002).
- Regional Editor-North America, Journal of Nondestructive Testing and Evaluation (2006-).
- Scientific Committee Member: International Symposium on Laser Ultrasonics: Science, Technology and Applications (2008-).
- Scientific Committee Member: International Conference on Photoacoustic and Photothermal Phenomena (ICPPP), (2009-).
- Board of Directors, International Photoacoustic and Photothermal Association (2011-).
- Scientific Advisory Board: IPTRADE Inc., Newton, MA (2007-2009).
- Founding member: BU Center for Nanoscience and Nanobiotechnology (CNN).
- Founder of the LENS (Learning Experiences for New Scientists) outreach program for junior high students.
- Korea University of Education and Technology, invited to present week long short-course entitled “Laser-based techniques in Nondestructive Evaluation,” (January, 2002 and August, 2002)
- Session Chair/Discussion Leader Invitation to Gordon Research Conference on Photoacoustic and Photothermal for the session on laser ultrasonic processes and applications. Conference held June 8-13, (2003)
- ARCS (Achievement Rewards for College Scientists) Foundation scholarship winner (1994)
- Selected to participate in international exchange program at the University of Ljubljana in Ljubljana, Slovenia by Johns Hopkins University (1994)
- Reviewer: Optics Letters, Optics Express, Journal of the Acoustical Society of America, Optical Engineering, Applied Physics Letters, Research in Nondestructive Evaluation, and NDT&E International, Chemical Reviews, Acoustics Research Letters Online (ARLO), Journal of Optics A, Measurement Science and Technology.

Awards won by students working in the Laser Acoustics Lab:

David Stobbe (PhD student) and Andrew Bakir (MS Student)

“Best Paper in Track” and “Best in Session” Awards for T.W Murray, A. Bakir, D.M. Stobbe, M.J. Kotelyanskii, R.A. Mair, M. Mehendale, X. Ru, J.D. Cohen, M.T. Schulberg, P. Mukundhan, and T.J. Kryman, “A New In-line Laser-based Acoustic Technique for Pillar Bump Metrology” International Symposium on Microelectronics (2015)

Jacob Dove (PhD, co-advisor Mark Borden)

2013/2014 Thomas & Brenda Geers Graduate Fellowship recipient

Puxiang Lai (PhD, co-advisor R.A. Roy):

Best Poster Award: P. Lai, T. W. Murray, and R. A. Roy, “Acousto-optic Imaging in the Near Infrared Using the Photorefractive Effect”, *Annual Research and Industrial Collaboration Conference of CenSSIS*, Northeastern University, Boston, MA, October, 2007.

Thomas Steen (PhD):

Provost’s Award: T. Steen and T.W. Murray, “Inspection of Functionally graded Coating Materials Using Frequency Domain Photoacoustic Microscopy”, *2007 Boston University Science and Technology Day*, Boston, Massachusetts.

Oluwaseyi Balogun (PhD):

Technology Commercialization Institute Award: O. Balogun, N. Pratt and T.W. Murray, “A Novel Technique for Enhancing the Signal to Noise Ratio of Laser Based Ultrasonic Systems”, *2004 Boston University Science and Technology Day*, Boston, Massachusetts.

Lei Sui (PhD; co-advisor R.A. Roy):

Provost’s Award: L. Sui, R. A. Roy, E. Bossy, and T. W. Murray, “Pulsed acousto-optic imaging (AOI) and its fusion with conventional diagnostic ultrasound”, *Science and Technology Day*, Boston University, Boston, MA, March 29, 2005.

Fairway-Lasersonix Student Paper Award: L. Sui, R. A. Roy, C. A. DiMarzio, F. Blonigen, and T. W. Murray, “Investigation of the photorefractive crystal based detection system for acousto-optical imaging (AOI) in highly diffuse media”, *Proc. SPIE 5697*, 136-144 (2005).

Best Poster Award: L. Sui, E. Bossy, T. W. Murray, and R. A. Roy, “The Marriage of Acousto-Optical Sensing (AOS) and Diagnostic Ultrasound: Augmenting Sound with Light”, *Annual Research and Industrial Collaboration Conference of CenSSIS*, Northeastern University, Boston, MA, October, 2004.

John H. and Helen Carey Fitzgerald Award (Co-recipient): for dissertation research

Ashwin Kumar (PhD, co-advisor K.L. Ekinici):

2005 Center for Nanoscience and Nanobiotechnology Award: A. Kumar , T. Kouh , O. Balogun , K. L. Ekinici and T.W. Murray, “Characterization of Nanoelectromechanical Systems using Phototacoustic Microscopy” *Science and Technology Day*, Boston University, Boston, MA, March 29, 2005.

PATENTS

*students and post-docs included on patents

Optical acoustic substrate assessment system and method

TW Murray, M Mehendale, M Kotelyanskii, R Mair, P Mukundhan

US Patent 9,576,862 (Filed 2014, Published 2017, associated with research activities at CU)

Exclusive licensing agreement reached with Rudolph Technologies in May 2014. This agreement generates royalty income for the university each year.

Device for laser-ultrasonic detection of flip chip attachment defects

M Klein, T Murray

US Patent 8,269,979 (Filed 2007, Published 2012, associated with research activities at BU)

Non-contact pressure sensing using laser-induced dielectric breakdown

RG Holt, TW Murray, JR Sukovich*

US Patent 8,240,215 (Filed 2010, Published 2012, associated with research activities at CU and BU)

Non-destructive imaging, characterization or measurement of thin items using laser-generated lamb waves

TW Murray, C Prada, O Balogun*

US Patent 7,798,000 (Filed 2006, Published 2010, associated with research activities at BU)

Enhanced detection of acousto-photonic emissions in optically turbid media using a photo-refractive crystal-based detection system

CA DiMarzio, RA Roy, TW Murray, FJ Blonigen*, LA Nieva*, L Sui*, G. Maguluri*

US Patent 7,652,773 (Filed 2005, Published 2010, associated with research activities at BU)

Characterization of micro-and nano scale materials by acoustic wave generation with a CW modulated laser

TW Murray

US Patent 7,649,632 (Filed 2005, Published 2010, associated with research activities at BU)

Laser-ultrasonic detection of flip chip attachment defects

M Klein, T Murray

US Patent 7,327,448 (Filed 2007, Published 2012, associated with research activities at BU)

Imaging through scattering media with high signal to noise ratio and resolution

R Piestun, H Ju*, J Dove*, AM Caravacca-Aguirre*, T Murray, D Conkey*

US Patent App. 14/913,958 (patent pending, Filed 2014, Published 2016, associated with research activities at CU)

Non-Destructive acoustic metrology for void detection

M. Mehendale, M. Kotelyanskii, T.W. Murray, R. Mair, P. Mukundhan, J.D. Dove*, R. Xueping, J. Cohen, T. Kryman

US Patent App. 15/515,126 (patent pending, Filed 2015, Published 2017, associated with research activities at CU)

High Resolution photoacoustic imaging in scattering media using structured illumination

T. Murray, P. Burgholzer, and M. Haltmeier

PCT/US2017/054133 (patent pending, PCT Filed 2017, associated with research activities at CU)

PHD STUDENTS FOR WHICH I CURRENTLY SERVE, AND HAVE SERVED, AS RESEARCH ADVISOR:

1. **Lei Sui** (Former BU Postdoc and PhD Student, co-advised by Ronald Roy)
Postdoc: Boston University (2005-2006)
Doctoral Degree (2005)
PhD Thesis: "Acousto-optic Imaging in Diffuse Media using Pulsed Ultrasound and the Photorefractive Effect"
Current Position: Ultrasound Research Scientist, General Electric, MA
2. **Oluwaseyi Balogun** (Former BU PhD Student)
Doctoral Degree (2006)
Ph.D. Thesis: "Materials Characterization using Frequency Domain Photoacoustic Microscopy"
Current Position: Associate Professor, Mechanical Engineering, Northwestern University
3. **Thomas Steen** (Former BU PhD Student)
Doctoral degree (2008)
PhD Thesis: "Inspection of Functionally Graded Coating Materials using Frequency Domain Photoacoustic Microscopy"

Current Position: Offshore Engineering Leader, GE Oil and Gas, TX

4. **Ashwin Sampathkumar** (Former BU PhD Student)
Doctoral degree (2010)
PhD Thesis: “Multiplexed operation of Nanoelectromechanical Systems (NEMS) Arrays”
Current Position: Scientist, Riverside Research Institute, NY
5. **Puxiang Lai** (Former BU PhD Student, co-advised by Ronald A. Roy)
Doctoral degree (2011)
PhD Thesis: “Photorefractive Crystal-based Acousto-optic Imaging (AOI) in the Near Infrared and its Applications”
Current Position: Assistant Professor, Hong Kong Polytechnic University, Kowloon, Hong Kong
6. **Hengyi Ju** (Former CU PhD Student)
Doctoral degree (2013)
PhD Thesis: “Ultrasound Assisted Cavitation around Pulsed Laser Illuminated Nanoparticles”
Current Position: Research Scientist, Eastman Chemical Company, MA
7. **Jacob Dove** (Former CU PhD Student, co-advised by Mark Borden)
Doctoral degree (2014)
PhD Thesis: “Optically Active Plasmonic Microbubbles”
Current Position: Research Scientist, Medtronic Corporation
8. **David Stobbe** (Current CU PhD Student)
Doctoral degree expected 2017
PhD Research Topic: Backward wave propagation in elastic plates
9. **Jordan Lum** (Current CU PhD Student, co-advised by Mark Borden)
Doctoral degree expected 2018
PhD Research Topic: Photoacoustic investigation of microbubble properties
10. **Marco Inzunza** (Current CU PhD Student)
Doctoral degree expected 2019
PhD Research Topic: Photoacoustic guided imaging in scattering media

SERVICE

Service that I have done at CU Boulder is listed below. A full list of service including that done at Boston University (2001-2009) is available upon request.

Department Service

- Infrastructure Committee Chair (fall 2016 -spring 2017)
- Department Executive Committee (fall 2016- spring 2017)
- Materials prelim committee (2016-2017)
- Bio prelim committee (2016)
- Associate Chair, Mechanical Engineering (spring 2015)
- Mechanical Engineering Executive Committee (spring 2015)
- Associate Chair, Mechanical Engineering (spring 2014/ fall 2014)
- Mechanical Engineering Executive Committee (spring 2014 /fall 2014)
- Mechanical Engineering Personnel/PUEC Committee (spring 2013)
- Chair of Industry Relations Committee (spring 2013)
- Associate Chair, Mechanical Engineering (fall 2013)
- Mechanical Engineering Executive Committee (spring/fall 2013)

- Personnel/PUEC Committee Fall 2012
- Industry Relations Committee Chair (spring 2012/fall 2012)
- Mechanical Engineering Executive Committee (spring and fall 2012)
- Search Committee Chair: Financial Manager Position (fall 2012)
- Search committee member: External Relations director (spring)
- Prepared Solid Mechanics Prelim Exam (spring 2012)
- Industry Relations Committee (spring 2011)
- Industry Relations Committee Chair (fall 2011)
- Mechanical Engineering Executive Committee (fall 2011)
- Mechanical Engineering Grade Appeal Committee (summer 2011)
- Mechanical Engineering Undergraduate Committee (spring 2010)
- Industry Relations Committee (fall 2010)
- Mechanical Engineering Undergraduate Committee (fall 2009)

College and University Service

- Imaging Science Interdisciplinary Research Theme Director 2018-
- Soft Materials Search Committee Chair 2017-
- Engineering Space Renovation Committee: College (summer 2015)
- BFA Leadership Institute (fall 2014/ spring 2015)
- IGP Competition Reviewer, University of Colorado

Professional Service

- Co-Chair and Organizer: *4th International Symposium on Laser Ultrasonics and Advanced Sensing* (with Sridhar Krishnaswamy and Oluwaseyi Balogun); Organized (together with the Co-chairs) all aspects of this conference including web site, abstract submission and review, session creation, call for papers, and social program. I also ran the student presentation competition at the conference. (~ 200 attendees) Evanston, IL (2015)
- Board Member, International Photoacoustic and Photothermal Association (IPPA) (2011-)
- Regional Editor North America: *Journal of Nondestructive Testing and Evaluation* (2006-)
- Session Chair, *5th International Symposium on Laser Ultrasonics and Advanced Sensing* (2016)
- Scientific Committee Member: *5th International Symposium on Laser Ultrasonics and Advanced Sensing* (2016)
- Proposal reviewer, the Research Foundation Flanders (FWO) Belgium (2016/ 2017)
- NSF Review Panel: Unsolicited Proposals submitted to the Dynamics, Control and Structural Diagnostics program and to the Mechanics of Materials and Structures programs.
- Scientific Committee Member: *18th International Conference on Photoacoustic and Photothermal Phenomena*, Novi Sad, Serbia (2015)
- Scientific Committee Member: *3rd International Symposium on Laser Ultrasonics and Advanced Sensing*, Yokohama, Japan (2013)
- Scientific Committee Member: *17th International Conference on Photoacoustic and Photothermal Phenomena*, Suzhou, China (2013)
- Chair, Biomedical Applications Session: *3rd International Symposium on Laser Ultrasonics and Advanced Sensing*, Yokohama, Japan (2013)
- Proposal reviewer SDSU/UCSD Cancer center comprehensive partnership (2012)
- Program Committee: *International Conference on Advanced Laser Applications in Science and Engineering (ICALASE)* Nanjing China (2012)
- Session Chair: *International Conference on Advanced Laser Applications in Science and Engineering* (2012)
- Scientific Committee Member, *16th International Conference on Photoacoustic and Photothermal Phenomena (ICPPP 16)* (2011)
- Session Chair, Medical, Dental, and Biological Applications, *16th International Conference on Photoacoustic and Photothermal Phenomena (ICPPP 16)* (2011)

- Proposal review French National Research Agency (2011)
- Proposal review National Research Foundation of Korea (NRF) (2011)
- Proposal review Research Council K.U.Leuven, Belgium (2011)
- Scientific Committee Member, 2nd International Symposium on Laser Ultrasonics, Talence, France (2010)
- Session Chair, Signal processing, modeling, and Imaging Session, 2nd International Symposium on Laser Ultrasonics (2010)
- Proposal Review: French National Research Agency (2010)
- Scientific Committee Member: 15th International Conference on Photoacoustic and Photothermal Phenomena (ICPPP15), Leuven, Belgium (2009)
- Numerous manuscript reviews: Optica, Biomedical Optics Express, Journal of Biomedical Optics, Applied Physics Letters, Optics Letters, Journal of Applied Physics, Physical Review Letters, etc.

TEACHING

Courses that I have taught at CU Boulder are listed below. A full list of courses including those taught at Boston University (2001-2009) is available upon request.

MCEN 2023 Statics and Structures (2009)
 MCEN 4228 Mechanical Failure of Engineering Materials (2009)
 MCEN 2023 Statics and Structures (2010)
 MCEN 4045 Senior Design (2010)
 MCEN 2023 Statics and Structures (2011)
 MCEN 4228 Mechanical Failure of Engineering Materials (2011)
 MCEN 4085 Mechanical Engineering Design Projects (2011)
 MCEN 3037 Data Analysis (2012)
 MCEN 4228 Mechanical Failure of Engineering Materials (2012)
 MCEN 4085 Mechanical Engineering Design Projects (2012)
 MCEN 5228 Graduate Design (2012)
 MCEN 3037 Data Analysis (2013)
 MCEN 4228 Mechanical Failure of Engineering Materials (2013)
 MCEN 4085 Mechanical Engineering Design Projects (2013)
 MCEN 5228 Graduate Design (2013)
 MCEN 3037 Data Analysis (2014)
 MCEN 4228 Mechanical Failure of Engineering Materials (spring and fall) (2014)
 MCEN 4085 Mechanical Engineering Design Projects (2014)
 MCEN 5228 Graduate Design (2014)

In 2015, I did not teach during the spring semester and was on sabbatical in the fall. However, I taught Mechanical Behavior of Materials as a seminar course at the Research Center for Nondestructive Testing (RECENDT) in Linz, Austria. Six students received credit for this course at Johannes Kepler University.

MCEN 4228 Mechanical Failure of Engineering Materials (2016)
 MCEN 2063 Mechanics of Solids (2017)
 MCEN 4228/5228 Ultrasound Imaging and Applications (2017)
 MCEN 4174/5174 Mechanical Failure of Engineering Materials (2017)

FCQ Scores (given as mean for all courses listed above)

Course Overall Rating: 5.0/6.0

Instructor Overall Rating 5.1/6.0

JOURNAL PUBLICATIONS

(google scholar: total citations 1990, h-index 29, i10-index 47)

*students and post-docs in my group (advised or co-advised)

1. J. Lum*, D.M. Stobbe*, M. Borden, and T.W. Murray, "Photoacoustic Evaluation of Temperature Effects on Microbubble Properties," *Appl. Phys. Lett.* Under Revision (2017).
2. D. Stobbe* and T.W. Murray, "Conical Dispersion of Lamb Waves in Elastic Plates," *Phys. Rev. B* 96, 144101 (2017).
3. T.W. Murray, M. Haltmeier, T. Berer, E. Leiss-Holzinger, and P. Burgholzer, "Super-resolution photoacoustic microscopy using blind structured illumination," *Optica* 4, 17-22 (2017).
4. C. Grunsteidl, T. W. Murray, T. Berer, and I. A. Veres, "Inverse characterization of plates using zero group velocity Lamb modes," *Ultrasonics* 65, 1 (2016).
5. M.A. Borden, J.D. Dove*, and T.W. Murray, "Plasmonic nanoparticle coated microbubbles for theranostic applications," in *Nanotheranostics for Personalized Medicine*, World Scientific (2016).
6. I.A. Veres, C. Grunsteidl, D.M. Stobbe*, and T.W. Murray, "Broad angle negative reflection and focusing of elastic waves from a plate edge," *Phys. Rev. B*, 93 (17), 174304 (2016).
7. J.S. Lum*, J.D. Dove*, T.W. Murray, and M.A. Borden, "Single Microbubble Measurements of Lipid Monolayer Viscoelastic Properties for Small-Amplitude Oscillations," *Langmuir* 32(37) 9410-9417 (2016).
8. T.W. Murray, A. Bakir*, D.M. Stobbe*, M.J. Kotelyanskii, R.A. Mair, M. Mehendale, X. Ru, J.D. Cohen, M.T. Schulberg, P. Mukundhan, and T.J. Kryman, "A New In-Line Laser-Based Acoustic Technique for Pillar Bump Metrology," *Journal of Microelectronics and Electronic Packaging*, 13(2) pp. 58-63 (2016).
9. D.B. Conkey, A.M. Caravaca-Aguirre, J.D. Dove*, H. Ju*, T.W. Murray, and R. Piestun, "Super-resolution imaging through a scattering wall," *Nature Communications* 6, 7902 (2015).
10. F.D. Philippe, T.W. Murray, and C. Prada, "Focusing on Plates: Controlling Guided Waves using Negative Refraction," *Scientific Reports* (5) 11112 (2015).
11. C. Grunsteidl, I. A. Veres, and T. W. Murray, "Experimental and numerical study of the excitability of zero group velocity Lamb waves by laser-ultrasound," *J. Acoust. Soc. Am.* 138(1) p. 242 (2015).
12. J.D. Dove*, M.A. Borden, and T.W. Murray, "Optically induced resonance of nanoparticle-loaded microbubbles," *Opt. Lett.* 39, 3732-3735 (2014).
13. J.D. Dove*, P.A. Mountford, T.W. Murray, and M.A. Borden, "Engineering optically triggered droplets for photoacoustic imaging and therapy," *Biomedical optics express* 5(12) pp. 4417 (2014).

14. A.M. Caravaca-Aguirre, D.B. Conkey, J.D. Dove*, H. Ju*, T.W. Murray, and R. Piestun, "High contrast three-dimensional imaging through scattering media by localized optical fluence enhancement," *Opt. Express* 21(22) pp. 26671 (2013).
15. J.D. Dove*, T.W. Murray, and M.A. Borden, "Enhanced photoacoustic response with plasmonic nanoparticle-templated microbubbles," *Soft Matter* 9 (32), pp. 7743 (2013).
16. H. Ju*, R.A. Roy, and T.W. Murray, "Gold nanoparticle targeted photoacoustic cavitation for potential deep tissue imaging and therapy," *Biomedical optics express* 4(1) pp. 66 (2013).
17. C. Grunsteidl, I.A. Veres, J. Roither, P. Burgholzer, T.W. Murray, and T. Berer, "Spatial and temporal frequency domain laser-ultrasound applied in the direct measurement of dispersion relations of surface acoustic waves," *Appl. Phys. Lett.* 102(1) 011103 (2013).
18. T.W. Murray, P. Lai*, and R.A. Roy, "Measuring tissue properties and monitoring therapeutic responses using acousto-optic imaging," *Ann. Biomed. Eng.* 40(2) pp. 474-485 (2012).
19. S. Bramhavar*, C. Prada, A.A. Maznev, A.G. Every, T.B. Norris, and T.W. Murray, "Negative refraction and focusing of elastic Lamb waves at an interface," *Phys. Rev. B*, 83, 014106 (2011).
20. O. Balogun* and T.W. Murray, "Frequency domain photoacoustics using intensity modulated laser sources," *Nondestructive Testing and Evaluation*, 26(3) pp. 335-351 (2011).
21. A. SampathKumar*, K.L. Ekinici, and T.W. Murray, "Multiplexed optical operation of distributed nanoelectromechanical systems," *Nano Lett.* 11(3) pp. 1014-1019 (2011).
22. P. Anderson, A. Sampathkumar*, T.W. Murray, D.F. Gaitan, and R.G. Holt, "Optical nucleation of bubble clouds in a high pressure spherical resonator," *J. Acoust. Soc. Am.* 130 (5) pp. 3389-3395 (2011).
23. P. Lai*, J.R. McLaughlan, A.B. Draught, T.W. Murray, R.O. Cleveland, and R.A. Roy, "Real time monitoring of high-intensity focused ultrasound lesion formation using acousto-optic sensing," *Ultrasound Med. Biol.* 37(2) pp. 239-252 (2011).
24. O. Balogun*, G.D. Cole, R. Huber, D. Chinn, T.W. Murray, and J.B. Spicer, "High spatial resolution sub-surface imaging using a laser based acoustic microscopy technique," *IEEE Trans. Ultrason. Ferroelectr. Freq. Control* 58(1) (2011).
25. J.R. McLaughlan, R.A. Roy, H. Ju*, and T.W. Murray, "Ultrasonic enhancement of photoacoustic emissions by nanoparticle-targeted cavitation," *Opt. Lett.* 35(13) (2010).
26. P. Lai*, R.A. Roy, T.W. Murray, "Quantitative characterization of turbid media using pressure contrast acousto-optic imaging," *Opt. Lett.* (34) 18 (2009).
27. S. Bramhavar*, B. Pouet, and T.W. Murray, "Superheterodyne detection of laser generated acoustic waves", *Appl. Phys. Lett.* , (94) 114102 (2009).
28. C. Prada, D. Clorennec, T.W. Murray, and D. Royer, "Influence of the anisotropy on zero-group velocity Lamb modes," *J. Acoust. Soc. Am.* (126) 620 (2009).

29. T.W. Murray, R.A. Roy, and R.G. Holt, "Laser-Ultrasonic Cavitation," *McGraw Hill Yearbook of Science and Technology 2008*, McGraw Hill (2008) (invited).
30. O. Balogun*, T.W. Murray, and C. Prada, "Simulation and measurement of the optical excitation of the S1 zero group velocity Lamb wave resonance in plates," *J. Appl. Phys.* 102, 064914 (2007)
31. T.W. Murray and R.A. Roy, "Illuminating sound: Imaging tissue optical properties with ultrasound," *Acoustics Today*, 3(3) pp. 17-23 (2007). (invited)
32. D. Clorenec, C. Prada, D. Royer, and T.W. Murray, "Laser impulse generation and interferometer detection of zero-group velocity Lamb mode resonance," *Appl. Phys. Lett.* 89, 024101 (2006).
33. A. Kumar*, T.W. Murray, and K.L. Ekinici, "Photothermal Operation of High Frequency Nano-electromechanical Systems," *Appl. Phys. Lett.* 88, 223104 (2006).
34. O. Balogun* and T.W. Murray, "A Frequency Domain Laser Based Ultrasonic System for Time Resolved Measurement of Broadband Acoustic Transients," *J. Appl. Phys.* 100,034902 (2006).
35. H. Yu, O. Balogun*, B. Li, T.W. Murray and X. Zhang, "Fabrication of Three-dimensional Microstructures Based on Singled-layered SU-8 For Lab-on-chip Applications," *Sensors and Actuators A: Physical*, 127(2), pp. 228-234 (2006).
36. T.L. Steen*, S.N. Basu, V.K. Sarin, and T.W. Murray, "Inspection of Ceramic Coatings Using Nanoindentation and Frequency Domain Photoacoustic Microscopy," *Journal of the Korean Society of Nondestructive Testing*, 26(6) pp. 390-402 (2006). (invited)
37. Murray, T.W. and Roy, R.A., "Illuminating sound: Imaging tissue optical properties with ultrasound," *Echoes* 16(4), pp. 1-3, (2006). (invited).
38. C. Prada, O. Balogun* and T.W. Murray, "Laser Based Ultrasonic Generation and Detection of Zero Group Velocity Lamb Waves in Thin Plates," *Appl. Phys. Lett.*, **87**, 194109 (2005).
39. T.W. Murray, O. Balogun*, T.L. Steen*, S. N. Basu and V. K. Sarin, "Inspection of Compositionally Graded Mullite Coatings Using Laser Based Ultrasonics", *International Journal of Refractory and Hard Materials*, **23**, pp. 322-329 (2005).
40. L. Sui*, R. A. Roy, C. A. DiMarzio, and T. W. Murray, "Imaging in Diffuse Media using Pulsed-Ultrasonic-Modulated Light and the Photorefractive Effect," *Appl. Opt.* **44** (19), pp. 4041-4048 (2005).
41. E. Bossy, L. Sui*, T. W. Murray, and R. A. Roy, "Fusion of conventional ultrasound imaging and acousto-optical imaging using a standard pulsed ultrasound scanner," *Opt. Lett.* **30** (7), pp. 744-746, (2005).
42. F. J. Blonigen, A. Nieva, C. A. DiMarzio, S. Manneville, L. Sui*, G. Maguluri*, T. W. Murray, and R. A. Roy, "Computations of the acoustically-induced phase shifts of optical paths in acousto-phonic imaging with photorefractive-based detection", *Appl. Opt.* **44**(18), pp. 3735-3746 (2005).

43. C. Farny, T. Wu, R.G. Holt, T.W. Murray, and R.A. Roy, "Nucleating Cavitation from Laser Illuminated Nanoparticles," *Acoust. Res. Lett. Online* **6**(3), pp. 138-143 (2005).
44. T. W. Murray, L. Sui*, G. Maguluri*, R. A. Roy, A. Nieva, F. Blonigen and C. A. DiMarzio, "Detection of Ultrasound Modulated Photons in Diffuse Media Using the Photorefractive Effect," *Opt. Lett.* **29** (21), pp. 2509-2511, (2004).
45. T.W. Murray and O. Balogun*, "High sensitivity laser based acoustic microscopy using a modulated laser source," *Appl. Phys. Lett.* **85**(14), pp. 2974 (2004).
46. H. Yu, O. Balogun*, B. Li, T.W. Murray and X. Zhang, "Building embedded microchannels using a single layered SU-8, and determining Young's modulus using a laser acoustic technique," *J. Micromech. Microeng.* **14**(11), pp. 1576 (2004).
47. C.A. DiMarzio and T.W. Murray, "Medical Imaging Techniques Combining Light and Ultrasound," *Subsurface Sensing Technologies and Applications*, **4**(4), pp. 289-309 (2003).
48. T.W. Murray and O. Balogun*, "Laser ultrasonic inspection of environmental barrier coatings," *Journal of the Korean Society of Nondestructive Testing*," **22**(6) pp. 599-608 (2002). (Invited)
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GRANTS FUNDED

- Non-invasive, high-resolution, 3D imaging and sensing through highly scattering materials, NSF, PI Piestun, Co-PI Murray (40%) \$410,000 (2016-2019)
- Negative Refraction and Localized Resonance of Guided Elastic Waves, NSF, PI: Murray \$279,268 (2013-2017).
- Semiconductor Metrology Phase IX, sponsored by Rudolph Technologies, PI: Murray \$37,924 (2016).
- Semiconductor Metrology Phase VIII, sponsored by Rudolph Technologies, PI: Murray \$19,148 (2016).
- Semiconductor Metrology Phase VII, sponsored by Rudolph Technologies, PI: Murray \$38,196 (2015).
- Semiconductor Metrology Phase VI, sponsored by Rudolph Technologies, PI: Murray \$37,745 (2015).
- Semiconductor Metrology Phase V, sponsored by Rudolph Technologies, PI: Murray \$38,130 (2014).
- Semiconductor Metrology Phase IV, sponsored by Rudolph Technologies, PI: Murray \$39,322 (2014).
- Metadamping: Breaking the Classical Stiffness-Dissipation Barrier in Materials Science, CU MSE Seed Grant PI: M. Hussein Co-PI Murray \$25,000 (2013-2014).
- Semiconductor Metrology Phase III, sponsored by Rudolph Technologies, PI: Murray \$40,573 (2013).
- Semiconductor Metrology Phase III supplemental, sponsored by Rudolph Technologies, PI: Murray \$9,150 (2012).
- Semiconductor Metrology Phase II, sponsored by Rudolph Technologies, PI: Murray \$74,339 (2012-2013).
- Semiconductor Metrology Phase II supplement, sponsored by Rudolph Technologies, 9/1/2012-9/30/2013 PI: Murray \$6,027 (2012-2013)
- Semiconductor Metrology, sponsored by Rudolph Technologies, PI: Murray \$25,471 (2012).
- Optically active microbubbles for multimodal imaging and therapy, ISG CU, \$46,000 PI: Murray (50%), Co-PI: Borden, \$46,000 (2012-2013).
- Ultrasonic Characterization of Protein Fouled Membranes, Pall Corporation, PI: Greenberg Co-PI: Murray (30%), \$89,804 (2012).
- Concentrate stream modeling and ultrasound spectroscopy, Bureau of Reclamation, PI: J. Pellegrino, Co-PI Murray (30%) \$81,000 (2011).

- CAREER: Integrated Research and Education in Nano- and Microscale Photoacoustic and Photothermal Microscopy, NSF, PI Murray \$400,000 (2005-2010)
- STTR Phase I: High-Frequency Laser Ultrasonic System for In-Situ Characterization of Nanoscale Materials, NSF (with Bossa Nova Tech) PI Murray \$70,123 (2007).
- NER: Massively Parallel Optomechanical Operation of Distributed Nanoelectromechanical Systems (NEMS) Arrays, NSF, PI Murray (50%) Co-PI: K.L. Ekinici, \$100,000 (2006-2007)
- Portable Lightweight Laser Ultrasonic System for Multipurpose NDT, NASA STTR Program, PI Murray \$43,324 (2006-2007).
- Acousto-Optic and Optoacoustic Imaging, Center for Subsurface Sensing and Imaging Systems (an NSF Engineering Research Center located at Northeastern University). AME PI: R.A. Roy, Project leader: Murray, ~\$120,000 per year (2003-2008).
- NER: Photoacoustic Characterization of Nanoelectromechanical Systems, NSF, PI Murray (50%) Co-PI: K.L. Ekinici, \$100,000 (2003-2005).
- Device and Method for High Sensitivity Laser Ultrasonic Characterization of Micro- and Nanoscale Materials, Internal grant from the Boston University Technology Development Office, PI Murray \$50,000 (2004).
- Phased Array Laser Ultrasonic Technique for Process Control of Underfill Integrity in Electronic Packages.” MDA subcontract through Lasson Tech., PI Murray, \$30,500 (2004).
- Acoustic Characterization of Mesoscale Objects, DOE funded through Lawrence Livermore National Lab, PI Murray \$160,000 (2004-2006).
- Advanced Laser Ultrasonic Receiver for Processing Control and In-Service Inspection of Thermal Barrier Coatings, MDA subcontract through Lasson Tech., PI Murray \$75,736 (2003-2004)
- FRG: Functionally Graded High-Al Mullite Environmental Barrier Coating, NSF, PI. S.N. Basu, Co-PI’s Sarin and Murray (30%), \$640,000 (2003-2007).
- NIRT: Advanced Characterization Techniques in Optics for Nanostructures, NSF, PI: M.S. Unlu, CoPI’s Murray (20%) and 4 others, \$1,222,082 (2002-2006).
- High Frequency Optoacoustic Imaging using Laser Array Interferometry, BU SPRInG Program, PI Murray, \$25,000 (2002).

SELECTED PRESENTATIONS AND CONFERENCE PROCEEDINGS

2007-2017, full list available upon request

*students and post-docs in my group (advised or co-advised)

P. Burgholzer, T.W. Murray, M. Haltmeier, T. Berer, and E. Leiss-Holzinger, “Photoacoustic super-resolution microscopy using blind structured speckle illumination,” SPIE Photonics West BIOS, San Francisco, CA (2017).

M. Klein, M. Wiedmann, and T.W. Murray, "Real Time Measurement of Aerospace Fastener Loading Using Laser Ultrasonics" 44th Annual Review of Progress in Quantitative Nondestructive Evaluation, Salt Lake City, UT (2017).

J.S. Lum*, T. W. Murray, and M. A. Borden, "Temperature effect on microbubble lipid shell elasticity," Colloid and Surface Science Symposium, New York, NY July (2017).

R. Mair, M. Kotelyanskii, M. Mehendale M, X. Ru, P. Mukundhan, T. Kryman, M. Liebens, S. Van Huylenbroeck, L. Haensel, A. Miller, E. Beyne, and T.W. Murray "Non-destructive acoustic metrology and void detection in 3 x 50 μm TSV." 27th Annual SEMI Advanced Semiconductor Manufacturing Conference (ASMC), IEEE (27th Annual SEMI Advanced Semiconductor Manufacturing Conference (ASMC), 54-59 (2016).

J.S. Lum*, J.D. Dove*, T.W. Murray, M.A. Borden "Microbubble Lipid Shell Elasticity: Simulation and Measurement." IEEE International Ultrasonics Symposium (IUS), IEEE, Jan (2016).

I. Veres, C. Grunsteidl, T.W. Murray "Broad angle negative reflection and focusing of elastic waves from a plate edge." Ultrasonics Symposium (IUS), 2016 IEEE International (18-23) (2016).

T.W. Murray, Clemens Grunsteidl, David M. Stobbe*, Istvan A. Veres, "Negative Refraction and Reflection of Lamb Waves" 5th International Symposium on Laser Ultrasonics and Advanced Sensing, Linz, Austria, July (2016).

T. Berer, M. Haltmeier, P. Burgholzer, E. Leiss-Holzinger, and T.W. Murray, "Sub-acoustic resolution photoacoustic microscopy using blind structured speckle illumination," Optics plus Ultrasound III, Nottingham UK, Nov.9 (2016).

T.W Murray, A. Bakir*, D.M. Stobbe*, M.J. Kotelyanskii, R.A. Mair, M. Mehendale, X. Ru, J.D. Cohen, M.T. Schulberg, P. Mukundhan, and T.J. Kryman, "A New In-line Laser-based Acoustic Technique for Pillar Bump Metrology" International Symposium on Microelectronics, No. 1, p. 000486-000492 (2015).

C. Grunsteidl, T. W. Murray, and I. A. Veres, "Numerical Investigation of the Excitability of Zero Group Velocity Lamb Waves," Physics Procedia 70, 159-162 (2015).

A.M. Caravaca-Aguirre, D.B. Conkey, E. Niv, J.D. Dove*, T.W. Murray*, and R. Piestun, "Extreme wavefront control for imaging in complex media," SPIE: Adaptive Optics and Wavefront Control for Biological Systems, Photonics West, San Francisco, CA, February (2015). (*invited*)

T.W Murray, A. Bakir*, D.M. Stobbe*, M.J. Kotelyanskii, R.A. Mair, M. Mehendale, X. Ru, J.D. Cohen, M.T. Schulberg, P. Mukundhan, and T.J. Kryman, "A New In-line Laser-based Acoustic Technique for Pillar Bump Metrology" International Symposium on Microelectronics, Orlando, Florida, October (2015).

I. A. Veres, C. Grunsteidl, T. W. Murray and A. Bakir*, “Numerical and experimental investigation of the excitability of zero group velocity Lamb waves,” 2015 International Congress on Ultrasonics, Metz France, May (2015).

R. A. Roy, P. Lai* and T. W. Murray, “Quantitative Optical Imaging in Diffuse Media by Pressure-contrast Acoustooptic Sensing,” 2015 International Congress on Ultrasonics, Metz France, May (2015).

R. A. Roy, P. Lai*, M. T. Adams, T. W. Murray and R. O. Cleveland, “Acousto-optic Monitoring of Thermal Lesions from High Intensity Focused Ultrasound Exposure,” 2015 International Congress on Ultrasonics, Metz France, May (2015).

C. Grunsteidl, T. W. Murray, A. Bakir*, and I. A. Veres, “Time-frequency study of zero group velocity Lamb waves,” Fourth International Symposium on Laser Ultrasonics and Advanced Sensing, Evanston, IL, June (2015).

D. Stobbe* and T.W. Murray, “Simulation of Negative Refraction of Ultrasonic Lamb Waves,” Fourth International Symposium on Laser Ultrasonics and Advanced Sensing, Evanston, IL, June (2015).

T.W. Murray, J.D. Dove*, P.A. Mountford, and M.A. Borden “Optically Active Microbubbles and Droplets for Contrast Enhanced Photoacoustic Imaging and Therapy,” 18th International Conference on Photoacoustic and Photothermal Phenomena, Novi Sad, Serbia, September (2015) (*invited*)

A. M. Caravaca Aguirre, D. B. Conkey, J. D. Dove*, H. Ju*, T. W. Murray, and R. Piestun, "Three-dimensional photoacoustic imaging through scattering media," in Biomedical Optics 2014, OSA Technical Digest (online) (Optical Society of America, 2014).

R. Mair, M. Mehehdale, M. Ketelyanskii, T.W. Murray, J.D. Dove*, X. Ru, J.C. Cohen, P. Mukundhan, and T.J. Kryman, “Non-destructive acoustic metrology for void detection in TSV’s,” Proceedings of the International Wafer Level Packaging Conference, (2014).

J.D. Dove*, T.W. Murray, and M.A. Borden, “Gold nanoparticle templated microbubbles for enhanced photoacoustic and ultrasound imaging” SPIE BiOS, Photons Plus Ultrasound: Imaging and Sensing, San Francisco, CA February (2014).

J.D. Dove*, M.A. Borden, and T.W. Murray, “Optically driven oscillations of nanoparticle loaded microbubbles,” IEEE International Ultrasonics Symposium, Chicago, IL September (2014).

A.M. Caravaca-Aguirre, D.B. Conkey, J.D. Dove*, H. Ju*, T.W. Murray, and R. Piestun, “Three-dimensional photoacoustic imaging through scattering media,” Biomedical Optics: BIOMED, Miami, FL April, (2014).

E. Kujundzic, J. Dove*, T. Murray, A. Lajmi, X. Wu, and A. R. Greenberg, “Using ultrasonic reflectometry to advantage for real-time detection of membrane fouling,” International Conference on Membranes, Suzhou, China July (2014).

T.W. Murray, "Laser based acoustic techniques for sensing and imaging," National Institute of Standards and Technology Seminar, Boulder CO April 2014. (*invited*)

I.A. Veres, C. Grunsteidl, J. Roither, P. Burgholzer, T.W. Murray, and T. Berer, Direct measurement of SAW dispersion relations in the k-w domains; numerical and experimental studies, Proceedings of the 2013 Joint UFFC, EFTF and PFM Symposium (2013).

C. Grunsteidl, I.A. Veres, T. Berer, J. Roither, T. Murray, and P. Burgholzer, Characterization of micro and nanolayers using frequency domain laser ultrasound, Proceedings of the 2013 Joint UFFC, EFTF and PFM Symposium (2013).

J.D. Dove*, M.A. Borden, and T.W. Murray, Plasmonic microbubbles as dual mode contrast agents with enhanced photoacoustic generation, American Chemical Society National Meeting, New Orleans, LA April (2013).

T.W. Murray, H. Ju*, and R.A. Roy, Ultrasound Assisted and Nanoparticle Targeted Photoacoustic Cavitation, 3rd International Symposium on Laser Ultrasonics and Advanced Sensing, Yokohama, Japan June (2013). (*invited*)

J.D. Dove*, T.W. Murray, and M.A. Borden, Characterization of optically induced microbubble oscillations, Biomedical Engineering Society Annual Meeting, Seattle, WA September (2013).

J.D. Dove*, T.W. Murray, M.A. Borden, Gold Nanoparticle-Templated Microbubbles as Dual Mode Contrast Agents with Enhanced Photoacoustic Signals, ASME Nano Engineering in Medicine and Biology, Boston MA, February, (2013).

T.W. Murray, Combining Sound and Light for Tissue Sensing, Imaging, and Therapy, Computational Optics Sensing and Imaging (COSI) seminar, University of Colorado, April (2013). (*invited*)

T.W. Murray, J.D. Dove*, H. Ju*, and M.A. Borden, Combining Sound and Light for Tissue Sensing, Imaging, and Therapy, 2013 Butcher Symposium, University of Colorado (2013).

T.W. Murray, H. Ju*, and R.A. Roy, "Nanoparticle Initiated Laser Ultrasonic Cavitation for tissue imaging and therapy" The International Conference on Advanced Laser Applications in Science and Engineering (ICALASE 2012), Nanjing China, November (2012). (*invited*)

Ronald A. Roy, Puxiang Lai*, and T.W. Murray, "Real-time monitoring of HIFU lesion formation using the interaction of light and sound" 37th International Conference on Ultrasonic Imaging and Tissue Characterization, Arlington VA June 2012 (*invited*)

A.A. Maznev, T.W. Murray, C. Prada and A.G. Every, Negative Refraction without Metamaterials, 2012 MRS Fall Meeting, Boston, MA November (2012).

X. Lu, J. Harvey, H. Ju*, T. Murray, K. Guerra, and J. Pellegrino, "Pulsed-power electromagnetic field effects on crystallization during desalination," North American Membrane Society, New Orleans, LA (2012).

J. Dove*, T.W. Murray, and M. Borden, "Gold nanoparticle-templated microbubbles as dual mode contrast agents with enhanced photoacoustic signals" ASME 2012 IMECE, Houston, TX November (2012).

Roy, R.A., Lai*, P., McLaughlan, J.R., Draudt, A.B., Cleveland. R.O., and Murray, T.W., "Imaging and monitoring non-cavitating focused ultrasound lesions using light and sound," Presented at the 161st Meeting of the Acoustical Society of America, Seattle, WA; abstract ref: J. Acoust. Soc. Am. 129(4 pt. 2), 2439 (2011).

Roy, R.A., McLaughlan, J.R., and Murray, T.W., "Enhancing targeted focused ultrasound therapy using light, sound, and nanoparticles," Presented at the 161st Meeting of the Acoustical Society of America, Seattle, WA; abstract ref: J. Acoust. Soc. Am. 129(4 pt. 2), 2673 (2011).

H. Ju* and T.W. Murray, "Gold nanorod targeted photoacoustic cavitation for tissue imaging and therapy," ASME IMECE, Denver CO, November (2011).

T.W. Murray, H. Ju*, J. McLaughlan, and R.A. Roy, "Nanoparticle targeted laser ultrasonic cavitation for imaging and therapy" International Conference on Photoacoustic and Photothermal Phenomena (ICPPP 16), Merida, MX November, (2011) (*invited*)

T.W. Murray, "Photoacoustic and Acousto-optic Imaging," Preclinical micro-ultrasound and photoacoustic imaging symposium, Anschutz Medical Campus, August (2011). (*invited*)

T.W. Murray, "Illuminating sound: Imaging tissue optical properties with ultrasound" C-TRIC Lecture Series, Department of Radiology, Anschutz Medical Campus August (2011). (*invited*)

J.R. McLaughlan, R.A. Roy, H. Ju*, and T.W. Murray, "Nanoparticle-targeted photoacoustic cavitation for tissue imaging," Proc. SPIE 7564, 756415 (2010).

P. Lai*, J.R. McLaughlan, A.B. Draudt, T.W. Murray, R.O. Cleveland, and R.A. Roy, "Monitoring and guidance of high intensity focused ultrasound exposures in real time using acousto-optic imaging: feasibility and demonstration ex vivo," Proc. SPIE 7564, 75642B (2010).

P.V. Chitnis, J. McLaughlan, J. Mamou, T. Murray, and R.A. Roy, "A photoacoustic sensor for monitoring in situ temperature during HIFU exposures," AIP Conf. Proc. 1215, 267 (2010).

T.W. Murray, C. Prada, and S. Bramhavar*, "Backward-Wave Propagation and Focusing in Plates and Thin Films," presented at ICCES'10 Special CMC Symposium on Advanced Materials, Las Vegas NV, March 30th (2010). (*Invited Keynote Presentation*)

T.W. Murray, P. Lai*, R.A. Roy, "Acousto-optic measurement of local optical properties in diffuse media," presented at the 2nd International Symposium on Laser Ultrasonics, Talence, France, July 5th (2010). (*invited*)

C. Prada, S. Bramhavar*, F. Philippe, and T.W. Murray, "Negative refraction of backward propagating Lamb waves," presented at the 2nd International Symposium on Laser Ultrasonics, Talence, France, July 5th (2010).

R.A. Roy, P. Lai*, J.R. McLaughlan, A.B. Draudt, R.O. Cleveland, and T.W. Murray, "Acousto-optic sensing for the real-time monitoring and feedback control of non-cavitating high-intensity focused ultrasound lesion formation in optically diffuse tissues" presented at the 2nd Panamerican/ Iberian Meeting on Acoustics, Cancun, Mexico Nov. 15th (2010).

P. Lai*, J.R. McLaughlan, A.B. Draudt, T.W. Murray, R.O. Cleveland, and R.A. Roy, "Acousto-optic monitoring of high-intensity focused ultrasound lesion formation in optically diffuse tissue," presented at the 159th meeting of the Acoustical Society of America, Baltimore, MD April 19th (2010).

F.D. Philippe, D. Clorennec, T.W. Murray, and C. Prada, "Negative refraction and focusing of backward propagating Lamb waves," presented at the 2nd Panamerican/ Iberian Meeting on Acoustics, Cancun, Mexico Nov. 15th (2010).

J.R. McLaughlan, T.W. Murray, and R.A. Roy, "Using optically activated nanoparticles to promote controlled lesion formation from high-intensity focused ultrasound exposures," presented at the 159th meeting of the Acoustical Society of America, Baltimore, MD April 19th (2010).

R. A. Roy, P. Lai*, J. R. McLaughlan, A. B. Draudt, and T. W. Murray, "The real-time monitoring and feedback control of non-cavitating HIFU lesion formation using light and sound" presented at Harvard Med., Boston MA Nov. 10th (2010). (*invited*)

T.W. Murray, "An overview of the Laser Acoustics Group," RECENDT-Research Center for Nondestructive Testing, Linz, Austria July (2010). (*invited*)

P. Lai*, R.A. Roy, T.W. Murray, "Sensing the optical properties of diffuse media by acousto-optic pressure contrast imaging," Proc. SPIE 7177, 71771G (2009).

A. B. Draudt, P. Lai*, T.W. Murray, R.O. Cleveland, and R.A. Roy, Acousto-optic detection of high intensity focused ultrasound lesions in real time, J. Acoust. Soc. Am. 126 2239 (2009). Published abstract presented at the 158th Meeting of the Acoustical Society of America, San Antonio, Texas, October 26-30, (2009).

J. R. McLaughlan, P.V. Chitnis, J. Mamou, T.W. Murray, and R.A. Roy, "The use of the photoacoustic effect for non-invasive temperature monitoring during high intensity focused ultrasound exposures," J. Acoust. Soc. Am. 126 2239 (2009). Published abstract presented at the 158th Meeting of the Acoustical Society of America, San Antonio, Texas, October 26-30, (2009).

P. Lai*, R.A. Roy, and T.W. Murray, "Quantitative sensing of optical properties of diffuse media by pressure contrast acousto-optic imaging," J. Acoust. Soc. Am. 126 2239 (2009). Published abstract presented at the 158th Meeting of the Acoustical Society of America, San Antonio, Texas, October 26-30, (2009).

J. R. McLaughlan, R.A. Roy, and T.W. Murray, "Nanoparticle targeted photoacoustic cavitation for deep tissue imaging," J. Acoust. Soc. Am. 126 2239 (2009). Published abstract presented at the 158th Meeting of the Acoustical Society of America, San Antonio, Texas, October 26-30, (2009).

T.W. Murray, S. Bramhavar*, A. Sampathkumar*, K.L. Ekinici, and B. Pouet, "Superheterodyne techniques in laser ultrasonics," J. Acoust. Soc. Am. 126 2239 (2009). Published abstract presented at the 158th Meeting of the Acoustical Society of America, San Antonio, Texas, October 26-30, (2009). (*invited*)

P. A. Anderson, T.W. Murray, and R.G. Holt, "Collapse dynamics of laser nucleated bubble clusters in a spherical resonator," J. Acoust. Soc. Am. 125 2561 (2009). Published abstract presented at the 157th Meeting of the Acoustical Society of America, Portland, Oregon, May 18-22 (2009).

P. A. Anderson, T.W. Murray, and R.G. Holt, "Laser nucleation of bubble clusters in a spherical resonator," J. Acoust. Soc. Am. 125 2561 (2009). Published abstract presented at the 157th Meeting of the Acoustical Society of America, Portland, Oregon, May 18-22, (2009).

J.R. Sukovich, T.W. Murray, and R.G. Holt, "Laser induced breakdown as a method for noncontact pressure measurement," Published abstract presented at the 157th Meeting of the Acoustical Society of America, Portland, Oregon, May 18-22, (2009).

T.W. Murray, P. Lai*, and R.A. Roy, "Optical property measurement in diffuse media using acousto-optic pressure contrast imaging," 34th International Symposium on Ultrasonic Imaging and Tissue Characterization, Arlington, VA June 10-12, (2009). (*invited*)

T.W. Murray, S. Bramhavar*, A. Sampathkumar*, and B. Pouet, "Superheterodyne laser ultrasonics and thin film spectroscopy," 15th International Conference on Photoacoustic and Photothermal Phenomena Leuven, 19-23 July (2009). (*invited*)

T.W. Murray, "Laser based acoustic techniques for materials characterization," 15th International Conference on Photoacoustic and Photothermal Phenomena Leuven, 19-23 July (2009). (*ICPPP Award Plenary Session*).

T.W. Murray, O. Balogun*, C. Prada, D. Clorennec, and D. Royer, "Theory and Applications of Laser Generated Zero-Group Velocity Lamb Mode Resonance, *Proceedings of the 34th Annual Review of Progress in Quantitative Nondestructive Evaluation*, AIP Conf. Proc. 925, 255 (2008).

T.L. Steen*, S.N. Basu, V.K. Sarin, and T.W. Murray, "Measurement and Analysis of Narrow-Band Surface Acoustic Waves in Ceramic Environmental Barrier Coatings," *Proceedings of the 34th Annual Review of Progress in Quantitative Nondestructive Evaluation*, AIP Conf. Proc. 925,294 (2008).

N. Kukhtarev, T. Kukhtareva, P. Land, J.C. Wang, T.W. Murray, P. Gnetenko, I.O. Faryna, P.M. Bukivskij, O.A. Shigiltchhoff, and A. Grabar, "Dynamic Holographic Interferometry in IR and Visible Range in Semiconductor Crystals for Acoustic Sensing (modeling and experimental realization)", *Proc. SPIE* 7003, 70030z (2008).

N. Kukhtarev, T. Kukhtareva, J.H. Caulfield, J.C. Wang, T.W. Murray, Yu.P. Gnatenko, I.O. Faryna, P.M. Bukivskij, R. Gamernyk, and A. Graber, "Two Channel IR Vibration Sensor based on Dynamic Gratings in Semiconductors and Pyroelectrics," *Proc. SPIE* 6940, 694035 (2008).

T.W. Murray, Mechanical Characterization of Coatings Using Frequency Domain Photoacoustic Microscopy," International Conference on Metallurgical Coatings and Thin Films *ICMCTF*, San Diego, CA (2008). (*invited*)

T. L. Steen*, S. N. Basu, V. K. Sarin and T. W. Murray, "Ceramic Coating Inspection Using Laser-Based Ultrasonics and Nanoindentation," *Proceedings of the 33rd Annual Review of Progress in Quantitative Nondestructive Evaluation*, AIP Conf. Proc. 894, 217 (2007).

B. F. Pouet, S. Breugnot, P. Clemenceau, and T.W. Murray, "Recent Progress in Multi-Channel Quadrature Interferometer: Demonstration of a Compact Fiberized Architecture," *Proceedings of the 33rd Annual Review of Progress in Quantitative Nondestructive Evaluation*, AIP Conf. Proc. 894, 1668 (2007).

S.N. Basu, T. Kulkarni, H.Z. Wang, T. Steen*, T.W. Murray, and V.K. Sarin, "Structure and Properties of Functionally Graded Environmental Barrier Coatings for Ceramic Components in Gas Turbines," *Proceeding of the International Conference on Advanced Materials and Composites (ICAMC-2007)*, 1050-1060 Trivandrum, India (2007).

S.N. Basu, V.K. Sarin, and T.W. Murray, "Environmental Barrier Coatings for Ceramic Components in Gas Turbines," OPE-2006, Chennai, India, *Pressure Vessels and Piping: Materials and Properties* (2007).

T.W. Murray, O. Balogun*, C. Prada, D. Clorennec, and D. Royer, "Theory and Applications of Laser Generated Zero-Group Velocity Lamb Mode Resonance, to be published in the Proceedings of the 34th Annual Review of Progress in Quantitative Nondestructive Evaluation, Golden, CO (2007).

T.L. Steen*, S.N. Basu, V.K. Sarin, and T.W. Murray, "Measurement and Analysis of Narrow-Band Surface Acoustic Waves in Ceramic Environmental Barrier Coatings," to be published in the Proceedings of the 34th Annual Review of Progress in Quantitative Nondestructive Evaluation, Golden, CO (2007).

P. Lai*, R.A. Roy, and T.W. Murray, "Acousto-optic imaging in the near infrared using the photorefractive effect," IEEE International Ultrasonics Symposium, New York, NY (2007).

R.A. Roy, T. Wu, C.H. Farny, T.W. Murray, and R.G. Holt, "Nucleating Inertial Cavitation "On Demand" using Laser-Illuminated Gold Nano-particles, with applications to HIFU Therapy" presented at the IEEE International Ultrasonics Symposium, New York, NY (2007).

S.N. Basu, T. Kulkarni, H.Z. Wang, T. Steen*, T.W. Murray, and V.K. Sarin, "Structure and Properties of Functionally Graded Environmental Barrier Coatings for Ceramic Components in Gas Turbines," International Conference on Advanced Materials and Composites (ICAMC-2007), Trivandrum, India (2007).

C. Prada, D. Clorennec, D. Royer, and T.W. Murray "Non-contact and local characterization of thin plates and cylindrical shells using the zero-group velocity Lamb modes, Acoustical Society of America, Salt Lake City, UT (2007).

T.W. Murray, "Laser based acoustic techniques for sensing and imaging: photoacoustic microscopy and acousto-optic imaging," National Institute of Standards and Technology, Boulder, CO (2007). (*invited*)

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LAY LANGUAGE PAPERS/ POPULAR PRESS

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