

# M. HASSAN ARBAB

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## EDUCATION

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- Ph.D. in Electrical Engineering and Nanotechnology** 6/2012  
Photonics Group, Applied Physics Laboratory and Electrical Engineering Department  
University of Washington, Seattle, WA  
Thesis: "Terahertz time-domain spectroscopy for chemical detection and burn characterization"
- Technology Entrepreneurship Certificate** 6/2010  
Center for Innovation and Entrepreneurship (CIE)  
Michal G. Foster School of Business, University of Washington, Seattle, WA
- M.S. in Electrical Engineering** 3/2008  
Electrical Engineering Department, University of Washington, Seattle, WA
- B.S. in Electrical Engineering** 9/2004  
Electrical and Computer Engineering Department  
Shahid Beheshti University (formerly National University of Iran), Tehran, Iran

## RESEARCH EXPERIENCE

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- Postdoctoral Research Associate** 1/2012-present  
Photonics Group, Applied Physics Laboratory, University of Washington, Seattle, WA
- Served as the Principal Investigator (PI), responsible for establishing and leading an independent research program on development of terahertz technology for biomedical imaging and nondestructive testing in industrial applications.
  - As PI or Co-PI, developed and submitted multiple successful research proposals to NIH, NSF, Coulter Foundation and UW CoMotion.
  - Managed the Terahertz lab, supervised a multidisciplinary group of researchers and graduate students.
  - Launched a new experimental laboratory focused on applications of terahertz spectroscopy technology.
- Research Assistant** 9/2006-12/2011  
Photonics Group, Applied Physics Laboratory, University of Washington, Seattle, WA
- Gained extensive experience with femtosecond lasers, regenerative amplifiers, ultrafast optics and non-linear optical processes; assembled and maintained several Terahertz spectroscopy setups.
  - Applied micro/nano fabrication and sample characterization techniques, including SEM and AFM.
  - Conducted Terahertz regime modeling of various rough surface and granularity induced electromagnetic scattering effects, including application of Wavelet Transform methods.
  - Investigated biomedical applications of Terahertz imaging in grading of burn wounds and providing therapeutic wound healing feedback.

## TEACHING EXPERIENCE

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- Instructor** 3/2015-6/2015  
Electrical Engineering Department, University of Washington, Seattle, WA
- EE361 - Applied Electromagnetics: Designed and gave daily lectures, developed homework assignments, lecture materials, midterm and final exams. Supervised two graduate Teaching Assistants and a grader in conducting lab sessions and grading homework assignments. Student evaluations: 4.3/5.

**Co-Instructor**

3/2015-6/2015

Biological Science Department, University of Washington, Bothell, WA

- BBio485: B – “Advanced Seminar in Biology: Tissue Regeneration.” Designed and gave lectures for 1/3 of a senior course on skin regeneration, apoptosis and necrosis, and role of imaging techniques in wound healing. Utilizing Active Learning strategies, developed lecture materials, homework assignments and exams, using both textbooks and primary archival literature. Student evaluations: 4.5/5.

**Teaching Assistant**

3/2005-8/2007

Electrical Engineering Department, University of Washington, Seattle, WA

- EE361 - Applied Electromagnetics: designed and conducted several laboratory sessions, developed homework assignments and lecture materials, graded lab reports and midterm exams.
- EE332 - Devices and Circuits II: Led laboratory experiment sessions and final class design projects, graded lab and project reports, and gave occasional lectures.

**PUBLICATIONS**

1. **M. H. Arbab**, S. Henry, A. Warsen, N. Farr, D. P. Winebrenner, A. M. McClintic, Y-N Wang, A. M. Hocking, N. Shubin, S. Arbabi, “Diagnosis of burn wounds using terahertz time-domain spectroscopy,” Proc. of IEEE IRMMW-THz Conference, Tucson, AZ, 2014.
2. **M. H. Arbab**, D. P. Winebrenner, T. C. Dickey, A. Chen, M. B. Klein, P. D. Mourad, “Terahertz spectroscopy for assessment of burn injuries in vivo,” J. of Biomedical Optics. 2013; 18:07704.
3. **M. H. Arbab**, D. P. Winebrenner, T. C. Dickey, A. Chen, M. B. Klein, and P. D. Mourad, “A Non-invasive Terahertz Assessment of 2<sup>nd</sup> and 3<sup>rd</sup> Degree Burn Wounds,” Proc. CLEO, San Jose, CA, 2012.
4. **M. H. Arbab**, T. C. Dickey, D. P. Winebrenner, A. Chen, M. B. Klein, and P. D. Mourad, “Terahertz reflectometry of burn wounds in a rat model,” Biomedical Optics Express 2, 2339-2347, 2011.
5. **M. H. Arbab**, T. C. Dickey, D. P. Winebrenner, A. Chen, and P. D. Mourad, “Characterization of burn injuries using terahertz time-domain spectroscopy,” Proc. SPIE 7890, 78900Q, 2011.
6. **M. H. Arbab**, D. P. Winebrenner, E. I. Thorsos, and A. Chen, “Retrieval of terahertz spectroscopic signatures in the presence of rough surface scattering using wavelet methods,” Appl. Phys. Lett. 97, 181903, 2010.
7. **M. Hassan Arbab**, Dale P. Winebrenner, Eric I. Thorsos and Antao Chen, “Application of wavelet transforms in terahertz spectroscopy of rough surface targets,” Proc. SPIE 7601, 760106, 2010.
8. **M. Hassan Arbab**, Antao Chen, Zhen Zhou, Eric Thorsos, Dale Winebrenner and Lisa Zurk, “Effect of surface scattering on terahertz time domain spectroscopy of chemicals,” Proc. SPIE 6893(1), p. 68930C, 2008.
9. **M. Hassan Arbab**, Dale P. Winebrenner, Antao Chen, Danling Wang, Eric I. Thorsos and Lisa M. Zurk, “Measurement and application of incoherent terahertz scattering using time-domain spectroscopy,” IEEE Proc. of IRMMW-THz, Pasadena, CA, 2008.
10. E. Afjei and **M. H. Arbab**, “Inadequacies in Finite Difference Solution of Linear and Non-Linear Magnetostatic Problems when Boundary Condition of the Third Kind is Used,” proceedings of IEEE ICEAA 2003, Torino, Italy.
11. E. Afjei and **M. H. Arbab**, “Magnetostatic Analysis by Employing Absorbing Boundary Condition,” Proceedings of the International Conference on Computational Methods in Sciences and Engineering, (ICCMSE 2003), World Scientific, p 4-8, 2003.
12. E. Afjei, J. Rashed Mohassel and **M. H. Arbab** “Significant Error Propagation in The Finite Difference Solution of Non-Linear Magnetostatic Problems Utilizing Boundary Conditions of The Third Kind”, International Journal of Engineering Transactions A, Vol. 16, No. 4, P.319-330, 2003.

## MANUSCRIPTS IN PREPARATION

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1. **M. H. Arbab**, S. Henry, A. Warsen, N. Farr, D. P. Winebrenner, A. M. McClintic, Y-N Wang, A. M. Hocking, N. Shubin, and S. Arbabi, "Differentiation of burn wounds in an in vivo porcine model using terahertz spectroscopy," *J. of Biomedical Optics*. 2016; Forthcoming.
2. **M. H. Arbab**, E. I. Thorsos, and Dale P. Winebrenner, "Zero-phase wavelet transform methods for THz-TDS imaging in non-destructive testing applications," to be submitted to *Optics Express*.
3. **M. H. Arbab**, Zachary Harris, Zachary Taylor, and Dale P. Winebrenner, "A handheld miniaturized terahertz time-domain Galvano-scanner for burn diagnostic imaging" to be submitted to *Optics Express*.
4. Wenwei Jin, Zachary Harris, Bing Chen, Peter Johnson, Delwin Elder, Philip Reid, Ruimin Xu, Larry Dalton and **M. H. Arbab**, "Terahertz Time-Domain characterization of nonlinearity in high-number density organic electro-optic polymers using matrix-based ATR formulation," to be submitted to *Advanced Materials*.
5. **M. H. Arbab**, Wenwei Jin, Zachary Harris, Bing Chen, and Dale P. Winebrenner, "A matrix decomposition solution for extraction of dielectric properties of stratified nonlinear thin films in terahertz regime," to be submitted to *IEEE Transaction on Terahertz Science and Technology*.

## INVITED TALKS AND CONFERENCE PRESENTATIONS

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1. **Invited Talk**, "Design and analysis of a handheld galvanoscanner for terahertz time-domain spectroscopic imaging in clinical settings" SPIE Photonics West Conference, San Francisco, CA, February, 2016.
2. **Invited Talk**, "Terahertz spectroscopy for classification of burn wounds in a standardized porcine model," SPIE Photonics West Conference, San Francisco, CA, February 2, 2014.
3. **Invited Talk**, "Diagnosis of Burn Severity Using Terahertz Spectroscopy," URSI-NRMS conference, Boulder, CO, January 10, 2014.
4. Conference presentation, "THz-TDS Characterization of High-number Density Organic Electro-optic Materials using Attenuated Total Reflection Method," 14<sup>th</sup> International Symposium on Mechatronic Technologies (ISOT), Seattle, WA, November 5, 2014.
5. **Invited Talk**, "In vivo assessment of skin burns using terahertz radiation," SPIE Photonics West Conference, San Francisco, CA, February 6, 2013.
6. Invited Seminar, "Terahertz time-domain spectroscopy for chemical detection and burn characterization," ABC seminar series, Department of Physics, University of Washington, January 16, 2013.
7. **Invited Seminar**, "Terahertz spectroscopy for chemical detection and burn characterization," Electrical Engineering Department Seminar, University of Massachusetts, Amherst, MA, March 2, 2012.
8. Conference Presentation, "A Non-invasive Terahertz Assessment of 2<sup>nd</sup> and 3<sup>rd</sup> Degree Burn Wounds," Optical Society of America CLEO Conference, San Jose, CA, June 2012.
9. Conference Presentation, "Characterization of burn injuries using terahertz time-domain spectroscopy," SPIE Photonics West Conference, San Francisco, CA, January 2011.
10. Conference Presentation, "Application of wavelet transforms in terahertz spectroscopy of rough surface targets," SPIE Photonics West Conference, San Francisco, CA, January 2010.
11. Conference Presentation "Measurement and application of incoherent terahertz scattering using time-domain spectroscopy," IEEE IRMMW-THz Conference, Pasadena, CA, September 2008.
12. Conference Presentation, "Effect of surface scattering on terahertz time domain spectroscopy of chemicals," SPIE Photonics West Conference, San Jose, CA, January 2008.

## CURRENT AND PENDING EXTERNAL RESEARCH FUNDING

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### **Broadband terahertz spectroscopic imaging for assessment of skin burns – R01 (PI: Arbab)**

Funding agency: National Institute of Health, National Institute of General Medical Sciences

Status: Awarded (total costs: \$2.36M over 5 years)

Project goals: Investigating a new imaging modality based on terahertz spectroscopy technology for improving the accuracy of the diagnosis of skin burns. Our ultimate objective is to test whether a THz spectral imager used in burn triage is able to guide the treatment plan by predicting the healing outcome of partial-thickness burns, and improve surgical delineation to minimize scar formation.

### **Broadband Terahertz Polarimetry for Photonic and Biomedical Applications (PI: Winebrenner, co-I Arbab)**

Funding agency: National Science Foundation

Status: Awarded (total costs: \$300,000 over 3 years)

Project goals: Developing a new real-time broadband Terahertz Time-Domain Polarimetry (THz-TDP) technique based on generation of complex THz polarized emissions from a single air-plasma source and rapid detection using spinning polarization-sensitive detectors. The new THz-TDP technology will be utilized in characterization of various new graphene-based photonic and plasmonic devices.

### **Noninvasive diagnosis of increased intracranial pressure using terahertz time-domain spectroscopy in a hydrocephalus model (PI: Arbab)**

Funding agency: Department of Defense, Congressionally Directed Medical Research Programs

Status: Pending

Project goals: We propose a research project whose ultimate goal is the replacement of the current invasive methods for detection of increased intracranial pressure (ICP) with a non-invasive procedure using terahertz time-domain spectroscopy, which would provide a measure of ICP on or near the battlefield, and therefore allow for early and preventative diagnosis of delayed-onset hydrocephalus following Traumatic Brain Injury.

### **Non-destructive evaluation with terahertz radiation (PI Winebrenner, co-I Arbab)**

Supporting agency: Center for Process Analytic and Control (CPAC), University of Washington

Status: Awarded (total costs: \$48,000)

Performance Period: 10/1/2012-10/1/2016

Project goals: We use Terahertz time-domain spectroscopy to study imperfections in foams, dielectrics and coatings commonly used in aerospace and pharmaceutical industries. Process control evaluations will include both frequency domain spectroscopy, and Wavelet-based time-domain analysis of film thickness consistency and identification of coating irregularities.

### **FDA approval for the Terahertz spectroscopy imaging modality (PI Arbab)**

Supporting agency: Center for Commercialization, University of Washington

Status: Awarded (total costs: \$10,000)

Performance Period: 9/1/2013-12/1/2016

Project goals: Supporting collaboration with external consultants and conducting animal safety studies in order to obtain FDA approval in form of an Investigational Device Exemption for a Terahertz spectral imager to conduct pilot human studies.

## COMPLETED RESEARCH PROJECTS

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### **Terahertz and GHz Spectroscopy for Imaging Burn Injuries (PI Mourad, co-I Arbab)**

Supporting agency: Coulter Foundation

Performance Period: 5/1/2012-5/1/2013

Project goals: Investigating the utility of Microwave (GHz) radiation in diagnosing the severity of burn injuries in comparison to higher frequencies through Terahertz time-domain spectroscopy.

**Terahertz spectroscopy and imaging for material detection and biomedical imaging (PI Arbab)**

Supporting agency: Applied Physics Laboratory, University of Washington

Performance Period: 8/1/2012-8/1/2014

Project goals: Developing an independent and externally funded research program based on THz spectroscopy technology (Start-up fund).

**AWARDS AND INTERNAL GRANTS**

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- CIMU Equipment Fabrication, Applied Physics Laboratory, UW (\$50,000, combined parts 1&2) 9/2014
- Center for Commercialization (C4C) Step and Gap (CGF) award (\$10,000, combined) 11/2013
- Strategic Applied Research (SAR) grant (\$25,000), Applied Physics Laboratory, UW 8/2012
- Coulter Foundation grant (\$15,000); Terahertz assessment of burns 6/2012
- APL Directorate Post-doctoral Fellowship 1/2012
- Summer Fellowship, Institute for Translational Health Sciences (ITHS) 6/2010
- Venture Capital Investment Competition (VCIC) intramural champion team (member),  
and 2<sup>nd</sup> place in Silicon Valley Regional round, Foster School of Business, UW 2/2010
- Technology Entrepreneurship Fellowship, Washington Research Foundation (WRF) 6/2009
- Over \$23K seed funding for research in biomedical applications of terahertz spectroscopy  
awarded by WRF 9/2008
- Three-year RA/TA Fellowship, Electrical Engineering Dept, University of Washington 6/2004

**UNIVERSITY AND PROFESSIONAL SERVICE**

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**Session Chair**

SPIE Photonics West Conference, BioS, San Francisco, CA, 2/2013, 2/2015

International Symposium on Optomechatronic Technologies, Seattle, WA 11/2014

**Organizing/Technical Committee Member,**

SPIE Photonics West Conference, BioS, San Francisco, CA, 2/2016

International Symposium on Optomechatronic Technologies, Seattle, WA 11/2014

**Independent Studies Mentor**

Mentoring several undergraduate and graduate students in Phys499 and EE599. UW, Seattle 3/2015-present

**Journal Reviewer**

3/2011-present

Applied Physics Letters, Optics Express, Optics Letter, Nanotechnology Journal, IEEE Sensors Journal, IEEE Transactions on Terahertz Science and Technology, Sensors and Actuators, Bioelectromagnetics, Optics Communications, Applied Optics, PIERS and Journal of Electromagnetic Waves and Applications, Optical Engineering Journal.

**Member**

4/2009-present

Sigma Xi, Optical Society of America (OSA), American Physical Society (APS), International Society for Optics and Photonics (SPIE), IEEE

**Vice President**

4/2011-1/2013

OSA student chapter, University of Washington

**President**

3/2007-3/2009

SPIE student chapter, University of Washington

## **PROFESSIONAL DEVELOPMENT**

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### **Future Faculty Fellows Program**

8/2015

University of Washington, Seattle, WA

- Attended a two-day series of workshops on several aspects of future faculty training, from job applications to setting up a new lab and mentoring graduate students and post-doctoral researchers.

### **Science Teaching Experience for Postdocs (STEP) program**

9/2014-9/2015

University of Washington, Seattle, WA

- Attended four workshops on evidence-based student-centered Active Learning teaching techniques.
- Received mentorship and feedback on course design, teaching strategies and final lecture delivery from University of Washington faculty member, Dr. Jeffery Jensen.

### **Grant Writing Workshop**

11/2014

Institute for Translational Health Sciences, Seattle, WA

- Attended a two-day workshop focused on many aspects of developing successful research proposals, particularly designed for NIH applications including mock study sessions conducted by faculty members at UW.