

# Yigit Aytac

APPLIED PHYSICIST, PH.D.

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## Summary

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*U.S. Permanent Resident*

- Expert at developing novel optical experiments and data acquisition algorithms. Extensive research history includes free-space and fiber optic photonic components and systems such as pulsed and continuous lasers, spectrometers, polarization optics, detectors, amplifiers, computer based instrumentation, and electrical components.

## Education

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### University of Iowa

*Iowa City, IA, USA*

PH.D. IN PHYSICS, GPA: 4.0/4.0

2016

- Research funded by National Reconnaissance Office Research Grant

### Marmara University

*Istanbul, Turkey*

B.S. IN PHYSICS, GPA: 3.8/4.0

2008

- Funded by Prime Ministry Scholarship

## Skills

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**Programming** Python, Mathematica, Octave, Matlab, Labview (Software: ImageJ, Lumerical, Sigmaplot, Origin, AutoCAD, SolidWorks,  $\LaTeX$ )

- Development of electro-optic based sensing techniques with an emphasis on the optical design
- Design and testing of spectral based sensors/emitters in VIS-NIR-MIR-LIR regions
- Development of signal acquisition algorithms pertaining to optical, electrical and time-resolved measurements
- Theoretical framework of nonlinear optics, semiconductors, ultrafast data interpretation and modeling

### Experimental

- Operation of ultra-fast pulsed lasers, optical parametric amplifiers and oscillators, and difference-frequency generation
- Experience with electronic materials and device processing, nano-fabrication, and characterization
- Experience in statistical modeling, time-series analysis, and signal processing (i.e., image processing, digital filtering, spectral analysis, probability)

**Languages** English, Turkish

## Experience

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### University of Maryland & Laboratory of Physical Sciences

*College Park, MD*

POSTDOCTORAL RESEARCH ASSOCIATE

*Jul. 2016 - Current*

- **Characterization of next generation optical structures and devices** in the near-, mid-, and long-wave infrared optical regions.
  - Study of the carrier relaxation dynamics of multi-layer black phosphorus as a function of time, probe energy, and probe polarization. The goal is to minimize the radiative and non-radiative (Auger, Schottky-Reed-Hall) recombination in black phosphorus (by optimizing the flake thickness, mechanical strain or substrate) for the applications such as optical modulation and photo-detection.
  - Time-resolved measurements of active plasmonic resonance in the Kretschmann configuration in metallic thin films. The measurement of changes in optical constants as a function of time delay between the arrival of strong pump pulse and a resonating probe pulse were used to determine characteristics of plasmonic states in a thin layer of gold.

## University of Iowa

Iowa City, IA

GRADUATE RESEARCH ASSISTANT & LEAD SCIENTIST IN ULTRAFAST LABORATORY

Aug. 2012 - Jun. 2016

- **Development of next-generation** Ga-free InAs/InAsSb type-II superlattices (T2SLs)
  - Minority carrier lifetime in mid-wave (MWIR) and long-wave (LWIR) infrared (IR) was improved more than a factor of 10 times longer compared to competitive IR detectors such as InAs/GaSb T2SLs and bulk HgCdTe detectors.
  - The band structure of Ga-free InAs/InAsSb type-II superlattices modified by varying the Sb mole fraction of the alloy, superlattice bandgap, and superlattice period thickness. In result, Auger recombination is suppressed by optimizing the final state of carriers that leads better IR detector performance in high operating temperatures and currents.
  - A first time all-optical measurement of the in-plane direction carrier mobility is successfully implemented to a set of Ga-free InAs/InAsSb T2SLs using four-wave-mixing technique. Orders of magnitude higher ambipolar diffusion coefficients are obtained for the Ga-free structures compared to the other competitive IR detector structures.
- **Improved functionality** of ultrafast system by designing and implementing an innovative electronic delay pump-probe method. This technique allows for accurate measurement of long-lived carrier lifetimes (nanoseconds to hundreds of microseconds) in narrow-bandgap semiconductors. The apparatus is designed specifically for carrier lifetime measurements of mid-wavelength and long-wavelength IR T2SLs, but is extremely versatile and is employable to a wide range of structures. Development of this apparatus has led to knowledge of the many and wide-ranging techniques available to measure carrier lifetimes in semiconductors.
- **Lead engineer and scientist** of the daily operation and maintenance of multiple femtosecond laser systems. The first being an amplified titanium:sapphire laser and two independent, white-light continuum seeded optical parametric amplifiers with difference-frequency generation stages. The second system is a high power titanium:sapphire oscillator and synchronously-pumped optical parametric oscillator outfitted with a difference-frequency generation stage.
- **Active development and design** of new and innovative experiments to investigate ultrafast phenomena in narrow-bandgap semiconductors. These semiconductors take part in astronomical applications such as Earth and Planetary Science missions or satellite applications to detect mid-range ballistic missiles.

## Georgia State University

Atlanta, GA

GRADUATE RESEARCH ASSISTANT

Aug. 2009- Aug. 2012

- **Growth and characterization** of III-V Compound superlattices and quantum wells/dots
  - A detector with five bands covering visible to LWIR was demonstrated using a GaAs-based n-p-n-architecture. A similar four-band detector without any cross-talk between the bands is proposed using InGaAs/InP material system.
  - A high-performance InGaAs/GaAs vertical quantum dot infrared photodetector (QDIP) with combined barrier of quaternary InAlGaAs and GaAs was investigated. A dominant long wavelength ( $\sim 10.2 \mu\text{m}$ ) response was observed from the device with high optical detectivity ( $\sim 10^{11}$  Jones).
- **Improved functionality** of superlattice IR detectors by implementing surface plasmon resonance based structures. Surface plasmon resonances in metallic and dielectric nano-arrays are used to enhance the response and detectivity of photo-detectors. Design of these sub-infrared wavelength size apertures were done using a finite-difference time-domain method software package for simulating electromagnetic systems. Structure growth and testing were done in the inorganic clean room facilities of the Georgia Institute of Technology.

## Honors & Awards

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2012-2016 **Research Fund**, National Reconnaissance Office Research Grant

Iowa City, IA

2011-2012 **Research Fund**, Brains and Behaviors Fellowship

Atlanta, GA

2008 **Awarded**, 1st Class Honors Prize for Science

Istanbul, Turkey

2004-2008 **Scholarship**, Prime Ministry Scholarship

Istanbul, Turkey

## Selected Journal Publications

2009-Present

- **Y. Aytac**, Martin Mittendorff, Thomas E. Murphy, "Mid-Wave Infrared Time-Resolved Differential-Transmission Measurements of Multi-Layer Black Phosphorus", *In Progress*, **2017**.
- M. Jadidi, **Y. Aytac**, R. J. Suess, A. B. Sushkov, G. S. Jenkins, J. G. Analytis, H D. Drew, Thomas E. Murphy, "Time-resolved Optical Study of Carrier Dynamics in the Weyl Semimetal TaAs", *Bulletin of the American Physical Society*, **2017**/3/16-62.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, J. Olesberg, M. E. Flatté, and T. F. Boggess. "Bandgap and temperature dependence of Auger recombination in InAs/InAsSb type-II superlattices" *Journal of Applied Physics* 119, 215705, **2016**.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess. "Evidence of a Shockley-Read-Hall Defect State Independent of the Superlattice Band Edge Energies in InAs/InAsSb Type-II Superlattices" *Phys. Rev. Applied* 5, 054016, **2016**.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess. "Temperature-dependent optical measurements of the dominant recombination mechanisms in InAs/InAsSb type-2 superlattices." *Journal of Applied Physics* 118, no. 12 **2015**: 125701.
- Provence, S. R., R. Ricker, **Y. Aytac**, T. F. Boggess, and J. P. Prineas. "High power cascaded mid-infrared InAs/GaSb light emitting diodes on mismatched GaAs." *Journal of Applied Physics* 118, no. 12 (**2015**): 123108.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess "Effects of layer thickness and alloy composition on carrier lifetimes in mid-wave infrared InAs/InAsSb superlattices.", *Applied Physics Letters* 105, no. 2 **2014**: 022107.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess. "Temperature-dependent carrier lifetime measurements of InAs/InAsSb T2SLs." *In SPIE OPTO*, **2014**.
- Adhikary, Sourav, Subhananda Chakrabarti, **Yigit Aytac**, and A. G. U. Perera. "Multi-spectral InAs/GaAs-based quantum dot infrared photodetector with quaternary (InAlGaAs) capping operates at low bias voltage." *In SPIE OPTO*, pp. 86340V-86340V. International Society for Optics and Photonics, **2013**.
- Adhikary, Sourav, **Yigit Aytac**, Srujan Meesala, Seyoum Wolde, AG Unil Perera, and Subhananda Chakrabarti. "A multicolor, broadband (5–20 $\mu\text{m}$ ), quaternary-capped InAs/GaAs quantum dot infrared photodetector." *Applied Physics Letters* 101, no. 26 **2012**: 261114.
- Chakrabarti, Subhananda, Sourav Adhikary, Nilanjan Halder, **Yigit Aytac**, and A. G. U. Perera. "Demonstration of high responsivity ( $\sim 2.16$  A/W) and detectivity ( $\sim 10^{11}$  Jones) in the long wavelength ( $\sim 10.2\mu\text{m}$ ) from InGaAs/GaAs quantum dot infrared photodetector with quaternary InAlGaAs capping." *In SPIE Defense, Security, and Sensing*, pp. 835338-835338. International Society for Optics and Photonics, **2012**.
- Chakrabarti, Subhananda, Sourav Adhikary, Nilanjan Halder, **Yigit Aytac**, and A. G. U. Perera. "High-performance, long-wave (  $10.2\mu\text{m}$ ) In-GaAs/GaAs quantum dot infrared photodetector with quaternary InAlGaAs capping." *Applied Physics Letters* 99, no. 18 **2011**: 181102.
- Ariyawansa, G., **Y. Aytac**, A. G. U. Perera, S. G. Matsik, M. Buchanan, Z. R. Wasilewski, and H. C. Liu. "Five-band bias-selectable integrated quantum well detector in an npn architecture." *Applied Physics Letters* 97, no. 231102 **2010**: 1-3.
- Perera, A. G. U., **Y. Aytac**, G. Ariyawansa, S. G. Matsik, M. Buchanan, Z. R. Wasilewski, S. Bhowmich et al. "Photo detectors for multi-spectral sensing." *In Nanotechnology (IEEE-NANO)*, 2011 11th IEEE Conference on, pp. 286-291. IEEE, **2011**.

## Selected Presentations

2009-Present

- **Y. Aytac**, M. Mittendorff, and T. E. Murphy, "Mid-Infrared Pump-Probe Measurements of Carrier Dynamics in Black Phosphorus", *Frontiers in Optics Conference*, Washington DC, September, **2017**.
- **Y. Aytac**, M. Mittendorff, and T. E. Murphy, "Broadband Third-Harmonic Generation in Black Phosphorus" *CLEO Conference*, San Jose CA, May, **2017**.
- **Y. Aytac**, "Time-Resolved Measurements of Carrier Lifetimes: Aiding the Development of Infrared Photodetectors" *Invited Speaker at Naval Research Laboratories*, Washington DC, March, **2016**.
- **Y. Aytac**, "Time-Resolved Measurements of Carrier Lifetimes: Aiding the Development of Infrared Photodetectors" *Invited Speaker at National Institute of Standards and Technology*, Gaithersburg, MD, November, **2015**.
- **Y. Aytac**, B. V. Olson, X. Le, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, J. Olesberg, M. E. Flatté, and T. F. Boggess, "Effect of superlattice period thickness on carrier lifetime in MWIR InAs/InAsSb type-II superlattices", (Oral presentation), *APS March meeting, Baltimore, MD*, **2016**.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess. "Temperature-dependent carrier lifetime measurements of InAs/InAsSb T2SLs." (Oral presentation) *In SPIE Photonics West OPTO, San Francisco, CA*, **2014**
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess, "Carrier recombination in mid-wave infrared InAs/InAsSb superlattices", (Poster presentation), *Optical Science and Technology Center Symposium, May 2014 (Iowa City, IA)*.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess, "Carrier recombination in mid-wave infrared InAs/InAsSb superlattices", (Oral presentation), *APS March meeting, Denver, CO*, **2014**.
- **Y. Aytac**, B. V. Olson, J. K. Kim, E. A. Shaner, S. D. Hawkins, J. F. Klem, M. E. Flatté, and T. F. Boggess. "Carrier lifetime measurements of mid-wave infrared InAs/InAs1-xSbx superlattices", (Oral presentation), *University of Iowa Jacobsen Conference, March 2014*.