

## Hua Tong, Ph.D.

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### Education

**Jan. 2001 – Aug. 2010,**

**Lehigh University (Bethlehem, Pennsylvania, USA)**

**Doctor of Philosophy (Ph.D.)** in Electrical Engineering, Department of Electrical and Computer Engineering

- Research Assistant
- PhD Advisor: Prof. Nelson Tansu (ECE, Lehigh), since November 2006
- Research Areas: physics of III-Nitride optoelectronics and thermoelectrics semiconductor alloys and nanostructures, epitaxy (MOCVD), fabrication and characterization of novel III-Nitride semiconductor devices.

**Sep. 1998 – Dec. 2000,**

**Tsinghua University (Beijing, China)**

**Master of Sciences (M.S.)** in Electronics Engineering, Department of Electronics Engineering

- Specialization: Micro-Opto-ElectroMechanical Systems (*Key project of the 863 National High Tech R&D Plan of China*)
- Thesis: Fabrication of Widely Tunable Detectors Based on MOEMS Technology

**Sep. 1994 – Jul. 1998,**

**Tsinghua University (Beijing, China)**

**Bachelor of Science (B.S.)** in Electronics Engineering, Department of Electronics Engineering

- Ranked 1<sup>st</sup> in class
- Thesis: Simulation of light propagation in Y branch waveguide using Full Vector Finite Difference Beam Propagation Method

### Awards & Honors Received

- **Tsinghua Excellent Student Scholarship** (1995,1996,1997), Tsinghua University
- **Tsinghua Outstanding Student Awards** (1995,1996,1997,1998), Tsinghua University
- **The Anadigics Fellowship** (2001 - 2003), Lehigh University
- **Lehigh University Research Assistantship**, Lehigh University

### Professional Experiences

**Aug. 2010 - present**

**Lehigh University (Bethlehem, PA, USA)**

#### **Research Associate**

Postdoctoral Advisor: Prof. Nelson Tansu

Department of Electrical and Computer Engineering (ECE)

P. C. Rossin College of Engineering and Applied Science

& Center for Optical Technologies (COT)

**Jan. 2001 – Aug. 2010****Lehigh University (Bethlehem, PA, USA)****Ph.D. Candidate and Research Assistant** (PhD Advisor: Prof. Nelson Tansu, since Nov 2006)

Department of Electrical and Computer Engineering (ECE)

P. C. Rossin College of Engineering and Applied Science

&amp; Center for Optical Technologies (COT)

- Conducting research in physics, materials and devices of III-Nitride based semiconductor alloys and nanostructures for thermoelectricity (including solid state cooling) applications
- Extensive theoretical simulation experience in photonic crystal bandgap simulation, FDTD simulation, first principle ab-initio calculation, phonon transport simulation
- Extensive MOCVD equipment experience from operation and maintenance of Veeco P-75 MOCVD reactor and supporting MOCVD facility (H<sub>2</sub> generator, gas purifier, scrubber system, gas cabinets, high purity lines, wet bench processing) at Lehigh.
- Extensive experience in characterization equipments from setting up and maintaining Philips PLM-100 Photoluminescence mapper, Bede QC2a X-Ray Diffractometer, Bio-Rad HL-5200 Hall measurement system, 3 $\omega$  thermal conductivity measurement system in Lehigh
- Extensive experience in working with equipment vendors and service suppliers
- Strong knowledge and hands-on experience in device fabrication equipments, such as photolithography, e-beam lithography, plasma enhanced chemical vapor deposition (PECVD), e-beam and thermal metal evaporators, chemical wet etching and reactive ion etching
- Strong knowledge and hands-on experience in material characterizations, such as photoluminescence (PL), X-ray diffraction (XRD), scanning electron microscopy (SEM), filmetrics, Hall measurement
- Extensive experience in computer hardwares/software and in charge of computer purchasing, intranet maintenance and group webpage maintenance
- Extensive experience in working with collaborators, taking leadership role and supportive role in various research projects

**May 2002 – Sep. 2002****Anadigics, Inc. (Warren, NJ, USA)****Characterization Engineer (Research Intern)**

- Worked in Device Characteristic and Testing Group
  - Conducted ruggedness test, load pull and source pull measurement of HBT using Maury ATS, DC IV and pulsed IV measurement
  - Conducted linearity test, two tone measurement
  - Conducted resistance measurement and side gate measurement
- Strong knowledge in RF and DC characterization equipments

**May 2001 – Sep. 2001****Anadigics, Inc. (Warren, NJ, USA)****Optoelectronics Engineer (Research Intern)**

- Worked in Opto-electronics group
  - In charge of the design of an Echelles grating DMUX for WDM
  - Involved in the design of coplanar electrodes for traveling-wave EO modulator and in the processing of MZ modulators

**Sep. 1998 – Dec. 2000****Tsinghua University (Beijing, China)****Research Assistant (MS Student)**

- Design and fabrication of widely tunable detectors based on MOEMS technology
  - Multilayer InP/Air pair structure and characteristic design
  - Device fabrication: optical lithography, non-selective and selective etching, electrode coating
  - Device measurement and characterization

## Skills

- Experienced in MOCVD, PECVD, metal evaporation, RTA, SEM, XRD, photomask design, e-beam lithography, photolithography, filmetrics, photoluminescence, Hall measurement
- Experienced in RF and optical characterization equipments
- Experienced in programming languages and software packages:
  - C/C++, FORTRAN, Assembly language, Matlab, Maple, Mathematica, MathCAD, Labview, Verilog/VHDL, Rsoft, Optiwave, Tanner L-Edit, DesignCAD, HTML/XML, Synopsys TCAD.
- Proficient in different Operation Systems: Windows, UNIX, Linux
  - IBM Certified Specialist – AS/400 Associate System Operator

## Patents or Invention Disclosures

- Nelson Tansu, [H. Tong](#), Jing Zhang, Guangyu Liu, and Gensheng Huang, *Novel techniques to achieve high thermoelectric figure of merit based on nitride semiconductor.* (Provisional Patent, and US Patent Pending)

## Refereed Journal and Conference Publications

1. J. H. Wang, [H. Tong](#), et. al., "Surface micromachining techniques in InP based Micro-Opto-Electro-Mechanical system," *Molecular Crystals and Liquefied Crystals*, vol.371, pp. 481-484, 2001.
2. J. Mao, [H. Tong](#), Dan Zhou, Zhensheng Jia, Jianhua Wang, and Shizhong Xie, "III-V semiconductor based surface-micromachined cantilevers for micro-opto-electro-mechanical systems," *SPIE 4580: Apoc 2001: Asia-Pacific Optical and Wireless Communications: Optoelectronics, Materials, and Devices for Communications*, pp. 257-261, Nov. 2001.
3. [H. Tong](#), A. D. McAulay, "Using Photonic Crystals in Adaptive Optic Wavefront Measurement," *ICATHS 2003: International Conference on Advanced Technologies for Homeland Security*, 2003.
4. [H. Tong](#), A. D. McAulay, "Wavefront Measurement by using Photonic Crystals," *SPIE 5435-13: Enabling photonic technologies for Aerospace Applications VI*, p. 97, April 2004.
5. A. D. McAulay, and [H. Tong](#), "Optical Clustering for Unsupervised Learning using Coupled Microring Resonators," *SPIE 5809-49: Signal Processing, Sensor Fusion, and Target Recognition XIV*, pp. 402-408, April 2005.
6. M. Jamil, Y. K. Ee, R. A. Arif, [H. Tong](#), and N. Tansu, "Study of Nucleation and Growth Modes of InN films by MOCVD on Sapphire Substrate for Photovoltaic Applications," in *Proc. of the MRS Spring 2007: Symposium Y: Thin-Film Compound Semiconductor Photovoltaics*, San Francisco, CA, April 2007.
7. M. Jamil, R. A. Arif, Y. K. Ee, [H. Tong](#), J. B. Higgins, and N. Tansu, "MOCVD Epitaxy of InN Films on GaN Templates Grown on Sapphire and Silicon (111) Substrates," in *Proc. of the 13<sup>th</sup> Biennial Workshop on Organometallic Vapor Phase Epitaxy (OMVPE) 2007*, Salt Lake City, UT, August 2007.
8. Y. K. Ee, P. Kumnorakaw, R. A. Arif, [H. Tong](#), J. F. Gilchrist, and N. Tansu, "Comparison of Numerical Modeling and Experiments of InGaN Quantum Wells Light Emitting Diodes with SiO<sub>2</sub> / Polystyrene Microlens Arrays," in *Proc. of the SPIE Photonics West 2008, Light-Emitting Diodes: Research, Manufacturing, and Applications XII*, vol. 6910, San Jose, CA, Jan 2008.
9. Y. K. Ee, P. Kumnorakaw, R. A. Arif, [H. Tong](#), J. F. Gilchrist, and N. Tansu, "Size Effects and Light Extraction Efficiency Optimization of III-Nitride Light Emitting Diodes with SiO<sub>2</sub> / Polystyrene Microlens Arrays," in *Proc. of the IEEE/OSA Conference on Lasers and Electro-Optics (CLEO) 2008*, paper CMKK6, San Jose, CA, May 2008.
10. (Invited Conference Paper) N. Tansu, R. A. Arif, Y. K. Ee, H. Zhao, [H. Tong](#), M. Jamil, and G. S. Huang, "Nano-Engineering of III-Nitride Semiconductor Optoelectronics and New Applications," in *Proc. of the International Conferences of Materials and Technologies (CIMTEC) 2008 – 3rd International Conference on Smart Materials, Structures and Systems*, Sicily, Italy, June 2008.
11. M. Jamil, R. A. Arif, Y. K. Ee, [H. Tong](#), J. B. Higgins, and N. Tansu, "MOCVD Epitaxy of InN Films on GaN Templates Grown on Sapphire and Silicon (111) Substrates," *Physica Stat. Solidi (a)*, vol. 205 (7), pp. 1619-1624, July 2008.
12. [H. Tong](#), H. Zhao, Y. K. Ee, V. A. Handara, J. A. Herbsommer, and N. Tansu, "Analysis of Thermoelectric Characteristics of III-Nitride Semiconductors," in *Proc. of the SPIE Photonics West 2009, Physics and Simulation of Optoelectronics Devices XVII*, San Jose, CA, Jan 2009.

13. Y. K. Ee, P. Kumnorkaew, R. A. Arif, [H. Tong](#), J. F. Gilchrist, and N. Tansu, "Enhancement of Light Extraction Efficiency of InGaN Quantum Wells Light-Emitting Diodes with Polydimethylsiloxane Concave Microstructures," in *Proc. of the SPIE Photonics West 2009, LEDs: Materials, Devices, and Applications for Solid State Lighting XIII*, San Jose, CA, Jan 2009.
14. H. Zhao, M. Jamil, G. S. Huang, [H. Tong](#), A. M. Driscoll, and N. Tansu, "Characteristics of InN Semiconductors Grown on Ga-Polar and N-Polar GaN Templates by Pulsed Metalorganic Vapor Phase Epitaxy," in *Proc. of the SPIE Photonics West 2009, Gallium Nitride Materials and Devices IV*, San Jose, CA, Jan 2009.
15. Y. K. Ee, P. Kumnorkaew, R. A. Arif, [H. Tong](#), J. F. Gilchrist, and N. Tansu, "The Use of Polydimethylsiloxane Concave Microstructures Arrays to Enhance Light Extraction Efficiency of InGaN Quantum Wells Light-Emitting Diodes," in *Proc. of the IEEE/OSA Conference on Lasers and Electro-Optics (CLEO) 2009*, Baltimore, MD, May 2009.
16. H. Zhao, M. Jamil, G. Y. Liu, G. S. Huang, [H. Tong](#), G. Xu, Y. J. Ding, and N. Tansu, "Pulsed Metalorganic Vapor Phase Epitaxy of In-Polar and N-Polar InN Semiconductors on GaN / Sapphire Templates for Terahertz Emitters," in *Proc. of the IEEE/OSA Conference on Lasers and Electro-Optics (CLEO) 2009*, Baltimore, MD, May 2009.
17. Y. K. Ee, P. Kumnorkaew, R. A. Arif, [H. Tong](#), H. Zhao, J. F. Gilchrist, and N. Tansu, "Optimization of Light Extraction Efficiency of III-Nitride Light-Emitting Diodes with Self-Assembled Colloidal-based Microlenses," *IEEE J. Selected Topics in Quantum Electronics*, vol. 15(4), pp.1218-1225, July-August 2009.
18. Y. K. Ee, P. Kumnorkaew, R. A. Arif, [H. Tong](#), J. F. Gilchrist, and N. Tansu, "Light Extraction Efficiency Enhancement of InGaN Quantum Wells Light-Emitting Diodes with Polydimethylsiloxane Concave Microstructures," *Optics Express*, vol. 17(16), pp.13747-13757, August 2009.
19. (**Invited Conference Paper**) N. Tansu, H. Zhao, R. A. Arif, Y. K. Ee, G. Y. Liu, X. H. Li, [H. Tong](#), and G. S. Huang, "Novel Approaches for Efficiency Enhancement in InGaN-Based Light Emitting Diodes," in *Proc. of the 2<sup>nd</sup> International Conference on White LEDs and Solid State Lighting 2009*, Taipei, Taiwan, December 2009.
20. [H. Tong](#), J. A. Herbsommer, V. A. Handara, H. Zhao, G. Y. Liu, and N. Tansu, "Thermal Conductivity Measurement of Pulsed-MOVPE InN Alloy Grown on GaN / Sapphire by  $3\omega$  Method," in *Proc. of the SPIE Photonics West 2010, Gallium Nitride Materials and Devices V*, San Francisco, CA, Jan 2010.
21. X. H. Li, [H. Tong](#), H. Zhao, and N. Tansu, "Band Structure Calculation of Dilute-As GaNAs by First Principle," in *Proc. of the SPIE Photonics West 2010, Physics and Simulation of Optoelectronics Devices XVIII*, San Francisco, CA, Jan 2010.
22. J. Zhang, [H. Tong](#), G. Y. Liu, J. A. Herbsommer, G. S. Huang, and N. Tansu, "Thermoelectric Properties of MOVPE Grown AllnN Lattice-Matched to GaN," in *Proc. of the American Physical Society (APS) Annual March Meeting 2010*, Portland, Oregon, March 2010.
23. (**Invited Review Article**) N. Tansu, H. P. Zhao, G. Y. Liu, X. H. Li, J. Zhang, [H. Tong](#), and Y. K. Ee, "Breakthrough in Photonics 2009:III-Photonics," *IEEE Photonics Journal*, vol. 2(2), pp.236-243, April 2010.
24. (**Invited Conference Paper**) H. P. Zhao, G. Y. Liu, X. H. Li, Y. K. Ee, [H. Tong](#), J. Zhang, G. S. Huang and N. Tansu, "Novel Growth and Device Concepts for High-Efficiency InGaN Quantum Wells Light-Emitting Diodes," in *Proc. of the IEEE/OSA Conference on Lasers and Electro-Optics (CLEO) 2010*, San Jose, CA, May 2010.
25. (**Invited Conference Paper**) H. P. Zhao, J. Zhang, G. Y. Liu, X. H. Li, Y. K. Ee, [H. Tong](#), T. Toma, G. S. Huang and N. Tansu, "Approaches for High-Efficiency InGaN Quantum Wells Light-Emitting Diodes -- Device Physics and Epitaxy Engineering," in *Proc. of the American Vacuum Society (AVS) Meeting 2010*, Ann-Arbor, MI, May 2010.
26. (**Invited Conference Paper**) N. Tansu, H. P. Zhao, J. Zhang, G. Y. Liu, X. H. Li, [H. Tong](#), T. Toma, G. S. Huang and Y. K. Ee, "Device Physics and Epitaxy Engineering for High-Efficiency III-Nitride Light-Emitting Diodes," in *Proc. of the International Union of Materials Research Societies - International Conference on Electronic Materials (IUMRS-ICEM) 2010*, Seoul, South Korea, August 2010.
27. [H. Tong](#), J. Zhang, G. Y. Liu, J. A. Herbsommer, G. S. Huang, and N. Tansu, "Thermoelectric Properties of Lattice-Matched AllnN Alloy Grown by Metalorganic Chemical Vapor Deposition," *Appl. Phys. Lett.*, vol. 97, Art. 112105, September 2010.  
**❖ The results represent the record thermoelectric figure of merits for all semiconductor materials at room temperature, including higher than those obtained from SiGe technologies.**
28. (**Late Breaking News Paper**) [H. Tong](#), J. Zhang, J. A. Herbsommer, G. S. Huang and N. Tansu, "Record Thermoelectric Figure of Merit for MOVPE-Grown AllnN Alloys with Various In-Contents," in *Proc. of the International Workshop on Nitride semiconductors (IWN) 2010*, Tampa Bay, FL, September 2010.

29. G. Y. Liu, H. Zhao, J. Zhang, [H. Tong](#), G. S. Huang, and N. Tansu, "Growths of Lattice-Matched AlInN / GaN for Optoelectronics Applications," in *Proc. of the 23<sup>rd</sup> Annual Meeting of the IEEE Photonics Society*, Paper WY5, Denver, CO, Nov 2010.

### **Submitted Journal and Conference Publications**

1. [H. Tong](#), J. Zhang, and N. Tansu, "Analysis of Thermoelectric Characteristics of Ternary III-Nitride Semiconductors," *J. Appl. Phys.* (submitted).
2. [H. Tong](#), J. Zhang, G. Y. Liu, J. A. Herbsommer, H. Zhao, and N. Tansu, "Extension of  $3\omega$  Method for Characterizing the Thermal Conductivity of Nitride-Based Thin Films," *J. Appl. Phys.* (submitted).
3. [H. Tong](#), J. Zhang, J. A. Herbsommer, V. A. Handara, H. Zhao, G. Y. Liu, and N. Tansu, "Thermal Conductivity and Seebeck Coefficient Measurements of Pulsed-MOVPE Grown InN Alloy," *Appl. Phys. Lett.* (submitted).
4. [H. Tong](#), J. Zhang, G. Y. Liu, J. A. Herbsommer, H. Zhao, and N. Tansu, "Experimental and Theoretical Comparison of Seebeck Coefficients in Nitride-Based Thin Films," *J. Appl. Phys.* (submitted).
5. [H. Tong](#), J. Zhang, J. A. Herbsommer, and N. Tansu, "Analysis of Thermoelectric Properties of AlInN Semiconductor Alloys," in *Proc. of the SPIE Photonics West 2011, Physics and Simulation of Optoelectronics Devices XIX*, San Francisco, CA, Jan 2011. (submitted).
6. J. Zhang, [H. Tong](#), G. Y. Liu, J. A. Herbsommer, G. S. Huang, and N. Tansu, "Record Thermoelectric Figure of Merit for MOVPE-Grown AlInN Alloys with Various In-Contents," *Physica Stat. Solidi (c)* (submitted).
7. J. Zhang, [H. Tong](#), and N. Tansu, "Thermal Conductivity Characteristics of Three-Layer Superlattices," in *Proc. of the SPIE Photonics West 2011, Physics and Simulation of Optoelectronics Devices XIX*, San Francisco, CA, Jan 2011. (submitted).
8. J. Zhang, [H. Tong](#), G. Y. Liu, J. A. Herbsommer, G. S. Huang, and N. Tansu, "Thermoelectric Properties of MOCVD-Grown AlInN Alloys with Various Compositions," in *Proc. of the SPIE Photonics West 2011, Gallium Nitride Materials and Devices VI*, San Francisco, CA, Jan 2011. (submitted).
9. J. Zhang, [H. Tong](#), and N. Tansu, "Minimum Thermal Conductivity of Three-Layer Superlattice Structure," *Phys. Rev. Lett.* (submitted).
10. X. H. Li, [H. Tong](#), H. Zhao, and N. Tansu, "First-Principle Studies of Dilute-Arsenide GaNAs Alloy," *Appl. Phys. Lett.* (submitted).
11. **(Invited Topical Review Article)** N. Tansu, H. Zhao, G. Y. Liu, X. H. Li, J. Zhang, [H. Tong](#), Y. K. Ee, and G. S. Huang, "Recent Progress on High Efficiency InGaN Quantum Wells and Quantum Dots Light Emitting Diodes for Solid Lighting – A Review," *J. Phys. D: Appl. Phys.* (submitted).
12. **(Invited Review Article)** H. Zhao, R. A. Arif, Y. K. Ee, [H. Tong](#), G. S. Huang, and N. Tansu "Physics of III-Nitride Gain Media for Laser Applications," *Lasers and Photonics Review* (submitted).
13. **(Invited Journal Article)** H. Zhao, R. A. Arif, Y. K. Ee, G. S. Huang, [H. Tong](#), and N. Tansu, "Approaches for High Internal Quantum Efficiency in InGaN Quantum Well Light Emitting Diodes," *IEEE Photonics Journal* (submitted).
14. **(Invited Review Article)** H. Zhao, M. Jamil, G. Y. Liu, G. S. Huang, [H. Tong](#), G. Xu, Y. J. Ding, and N. Tansu "Pulsed MOCVD Growth of In-Polar and N-Polar InN Semiconductors for Terahertz Emitters," *Materials* (submitted).

## **References**

1. **Prof. Nelson Tansu** (PhD Advisor)  
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