

# Ashish Agrawal

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## CONTACT INFORMATION

Nanoelectronic Devices and Circuits Lab  
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The Pennsylvania State University  
University Park, PA 16802 USA

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## RESEARCH INTERESTS

Energy-efficient transistors, High- $\kappa$ /III-V Interface Characterization and Analysis, Transport in Nanoscale Devices, Narrow-gap Quantum Well Transistors, Novel Physics, Materials and Architectures for Energy Efficient Devices

## EDUCATION

**Pennsylvania State University**, University Park, Pennsylvania USA

Ph. D. Candidate, Electrical Engineering, August 2011-June 2014(expected)

- GPA : 3.8/4.00
- Dissertation Topic: "Novel Contact Architectures for Low Contact Resistivity MOSFET Source/Drain Applications"
- Advisor: Prof. Suman Datta

**Pennsylvania State University**, University Park, Pennsylvania USA

Master of Science, Electrical Engineering, August 2009-2011

- GPA : 3.8/4.00
- Dissertation Topic: "Experimental Study of Low-Field Transport in Highly Confined Arsenide-Antimonide Quantum Well Heterostructures"
- Advisor: Prof. Suman Datta

**National Institute of Technology**, Nagpur, INDIA

B.Tech, Electronics and Communication Engineering, May 2005 - August 2009

- GPA : 7.78/10
- Dissertation Topic: "Autonomous Wireless Robotic Arm with Proximity Sensors"
- Advisor: Prof. Avinash Keskar

## RESEARCH EXPERIENCE

**Intel Corporation**, Hillsboro, Oregon USA

*Graduate Technical Intern*

**May, 2013 - August, 2013**

- Ultra-fast pulsed measurement and Impedance Spectroscopy characterization of novel materials for electronic non-volatile memory application

**Pennsylvania State University**, University Park, Pennsylvania USA

*Graduate Research Assistant*

**March, 2010 - present**

- Fabrication, Characterization and Analysis of Multi-Gate Compressively Strained Ge Quantum Well MOSFET (MuQFET) for P-Channel Application
- Fermi Level Unpinning and Metal-Insulator-Semiconductor contact schemes for ultra-low resistivity, scaled ohmic contacts on Si and Ge
- Substrate and Channel orientation dependent electron and hole transport in Silicon and Germanium: Planar MOSFET vs. FinFET
- Comprehensive DC and RF characterization and analysis of mixed Arsenide-Antimonide channel quantum well MOSFETs for low power logic and RF applications
- Experimental determination and analysis of dominant scattering mechanisms in mixed Arsenide-Antimonide for electrons and compressively strained InSb QW for hole transport
- Low frequency noise measurement and analysis on Arsenide-Antimonide HEMT
- Performance analysis and TCAD modeling of III-V Interband Tunnel Field Effect transistors

Conference

Ali, A.; Madan, H.; Misra, R.; Hwang, E., **Agrawal, A.**; Ramirez, I.; Schiffer, P.; Jackson, T. N.; Mohny, S. E.; Boos, J. B.; Bennett, B. R.; Geppert, I.; Eizenberg, M.; Datta, S.; “Advanced Composite High- $\kappa$  Gate Stack for Mixed Anion Arsenide-Antimonide Quantum Well Transistors,” *Electron Devices Meeting (IEDM), 2010 IEEE International*, vol., no., pp.6.3.1-6.3.4, 6-8 December 2010.

**Agrawal A.**; Ali A.; Misra R.; Schiffer P. E.; Bennett B. R.; Boos J. B.; Datta S.; “Experimental Determination of Dominant Scattering Mechanisms in Scaled InAsSb Quantum Well”, *Device Research Conference (DRC), 2011 69th Annual* , vol., no., pp.27-28, 20-22 June 2011

**Agrawal A.**; Ali A.; Misra R.; Schiffer P. E.; Bennett B. R.; Boos J. B.; Datta S.; “Low Field Electron Transport in Mixed Arsenide Antimonide Quantum Well Heterostructures”, *Electronics Material Conference (EMC), Univ. of California, Santa Barbara*, June 2011.

C. D. Young, M. Baykan, **A. Agrawal**, H. Madan, K. Akarvardar, C. Hobbs, I. OK, W. Taylor, C. E. Smith, M. M. Hussain, T. Nishida, S. Thompson, P. Majhi, P. Kirsch, S. Datta and R. Jammy, “Critical Discussion on (100) and (110) Orientation Dependent Transport : nMOS Planar and FinFET”, *VLSI Technology (VLSIT), 2011 Symposium on* , vol., no., pp.18-19, 14-16 June 2011

Ahmed K.; Chopra S.; **Agrawal A.**; Datta S.; “ Benchmarking of Novel Contact Architectures on Silicon and Germanium”, *Silicon-Germanium Technology and Device Meeting (ISTDM), 2012 International* , vol., no., pp.1-2, 4-6 June 2012

Hollander M.; **Agrawal A.**; Bresnehan M.; LaBella M.; Trumbull K.; Cavaleiro R.; Datta S.; Robinson J.; “ High Performance, Large Area Graphene Transistors on Quasi-Free-Standing Graphene Using Synthetic Hexagonal Boron Nitride Gate Dielectrics”, *Device Research Conference (DRC), 2012 70th Annual* , vol., no., pp.177-178, 18-20 June 2012

**Agrawal, A.**; Park J.; Ahmed K.; Datta S.; “Experimental Demonstration of “Cold” Low Contact Resistivity Ohmic Contacts on Moderately Doped n-Ge with in-situ Atomic Hydrogen Clean”, *Device Research Conference (DRC), 2012 70th Annual* , vol., no., pp.101-102, 18-20 June 2012

**Agrawal A.**; Lin J. C.; Zheng B.; Sharma S.; Chopra S.; Wang K.; Gelatos A.; Mohny S. E.; Datta S.; “Barrier Height Reduction to 0.15eV and Contact Resistivity Reduction to  $9.1 \times 10^{-9} \Omega - \text{cm}^2$  Using Ultrathin  $\text{TiO}_{2-x}$  Interlayer between Metal and Silicon”, *VLSI Technology (VLSIT), 2013 Symposium on* , vol., no., pp.T200,T201, 11-13 June 2013

Barth M.;**Agrawal A.**; Ali A.; Fastenau J.; Loubychev D.; Liu W. K.; Datta S.; “Compressively Strained InSb MOSFETs with High Hole Mobility for P-Channel Application”, *Device Research Conference (DRC), 2013 71st Annual* , vol., no., pp.21,22, 23-26 June 2013

Journal

Ali, A.; Madan, H.; Misra, R.; **Agrawal, A.**; Schiffer, P.; Boos, J. B.; Bennett, B. R.; Datta, S.; “Experimental Determination of Quantum and Centroid Capacitance in Arsenide-Antimonide Quantum-Well MOSFETs Incorporating Non-Parabolicity Effect,” *IEEE Trans. Electron Devices*, vol.58, no. 5, pp. 1397-1403, May 2011.

Mohata D.; Mookerjea S.; **Agrawal A.**; Li Y.; Mayer T.; Narayanan V.; Liu A.; Loubychev D.; Fastenau J.; Datta S.; “Experimental Staggered-Source and N+ Pocket-Doped Channel III-V Tunnel Field-Effect Transistors and Their Scalabilities,” *Appl. Phys. Express* 4 (2011) 024105.

Ali, A.; Madan, H.; **Agrawal, A.**; Ramirez, I.; Misra, R.; Boos, J. B.; Bennett, B. R.; Datta, S.; , “ Enhancement Mode Antimonide Quantum Well MOSFETs With High Electron Mobility and GHz Small-Signal Switching Performance,” *IEEE Electron Device Lett.*, vol. 32, no.12, pp.1689-1691, Dec. 2011

**Agrawal A.;** Shukla N.; Ahmed K.; Datta S.; “ A Unified Model for Insulator Selection to Form Ultra-Low Resistivity MIS Contacts to n-Si, n-Ge and n-InGaAs”, *Appl. Phys. Lett.* 101, 042108 (2012).

Hollander M.; **Agrawal A.;** Bresnehan M.; Labella M.; LaBella M.; Trumbull K.; Cavaleiro R.; Snyder D.; Datta S.; Robinson J.; “Effect of Synthetic Hexagonal Boron Nitride on Charge Transport in Quasi- Freestanding Epitaxial Graphene”, *submitted to SMALL*.

**Agrawal A.;** Madan H.; Ali A.; Misra R.; Barth M.; Loubychev D.; Liu A.; Fastenau J.; Lindemuth J.; Hudait M.; Datta S.; “Experimental and Theoretical Investigation of Low-Field Hole Transport in P-Channel Strained InSb Quantum Well Heterostructures”, *submitted to Applied Physics Letters*.

**Agrawal A.;** Lin J. C.; Barth M.; White R.; Zheng B.; Sharma S.; Chopra S.; Wang K.; Gelatos A.; Mohny S. E.; Datta S.; “Fermi level Depinning and Contact Resistivity Reduction using a Reduced Titania Interlayer in n-Silicon Metal-Insulator-Semiconductor Ohmic Contacts”, *submitted to Applied Physics Letters*

#### INVITED TALKS

**Agrawal A.;** “ Future of MOS Transistors”, Micro- and Nanoelectronics Group, *Visvesvaraya National Institute of Technology (VNIT)*, Jan. 2011.

**Agrawal A.;** “ Fermi level Unpinning and Contact Resistivity Reduction using MIS Contacts”, Micro- and Nanoelectronics Group, *Visvesvaraya National Institute of Technology (VNIT)*, July 2012.

#### TECHNICAL SKILLS Characterization

- AC, DC, Ultra-fast Transient Measurements
- High-k/III-V Capacitance/Conductance Measurements, Impedance Spectroscopy and Interface Analysis
- RF Characterization and Modeling, Cryogenic Measurements and Analysis
- Low-Frequency Noise Measurement

#### Fabrication

- Sub-micron Contact, Stepper and E-Beam Lithography and Patterning
- ICP Dry Etch, Wet Etch Techniques
- Atomic Layer Deposition, Metal Evaporation and Sputtering
- Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), X-Ray Photoelectron Spectroscopy (XPS), Auger Electron Spectroscopy (AES), Secondary Ion Mass Spectroscopy (SIMS), X-Ray Diffraction (XRD)

#### Software

- Synopsys TCAD, NextNano, SPICE
- MATLAB, C, C++, Java, Visual Basic, LabVIEW, LATEX
- Windows, Linux

#### AWARDS AND HONORS

- *Nominated for Best Student Paper Award* at 2013 Symposium on VLSI Technology
- *Won Best Student Paper Award* at 70th Annual Device Research Conference, 2012
- *2nd Position* in International Robotics Competition, Indian Institute of Technology (IIT), Kanpur, India 2008
- *National Top 1%* in All India Engineering Entrance Examination (AIEEE), 2005