

Helin Cao

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Rm G57, Purdue University, 525 Northwestern Ave., West Lafayette, IN, 47907

Education

Pursuing Ph.D. Solid state physics: Nano-materials and devices Aug. 2007 – Dec. 2012 (expected)

Physics Department & Birck Nanotechnology Center, Purdue University, West Lafayette, IN

Thesis advisor: Yong P. Chen

Graduate Study Solid state physics Aug. 2006 - May 2007

Physics and Engineering Physics, Tulane University, New Orleans, LA

M. S. and B. S. Theoretical physics: quantum optics Sep. 1998 - Jun. 2006

Physics Department, University of Science and Technology of China (USTC), Hefei, China

Technical Skills

Film synthesis and treatment: graphene exfoliation, CVD, PECVD, ALD, plasma etching, wet etching

Device fabrication: photolithography, e-beam lithography, thermal evaporator, e-beam evaporator

Sample surface and structure characterization: ellipsometry, Raman spectroscopy, XRD, AFM, STM, SEM

Low temperature cryogenic coolant: He-3, He-4

Programming: C, MATLAB, Igor

Experience

Research Assistant in Quantum Matter and Devices Lab, Purdue University Aug. 2009 - present

- Investigated electronic properties of topological insulator (TI) materials. (Funded by NSF and DARPA)
- Synthesized graphene by CVD on Cu substrate. Characterized the structure and electronic properties. Fabricated graphitic thin film synthesized on Ni into FET devices and characterized the electronic properties. (Funded by NRI-MIND and NSF) Aug. 2009 - 2011
- Worked in the Center for Nanoscale Materials at Argonne National Laboratory using the ultrahigh vacuum STM and PPMS. Dec. 2009 - Aug. 2010
- Worked in DC Field Facilities at National High Magnetic Field Laboratory using the superconducting magnet (up to 18 T) and resistive magnet (up to 35 T). 2008 - present

Teaching Assistant and Graduate Mentor

- Department of Physics, Purdue University, West Lafayette, IN
 - PHYS 570X: Carbon Nanophysics I Jan.- May, 2009 & Jan.- May 2010
 - PHYS 515: Thermal and Statistical Physics Aug.- Dec. 2009
- Department of Physics, Tulane University, New Orleans, LA
 - PHYS 121: Introductory Physics I Labs Aug. 2006 - May 2007
- Graduate Mentor: Summer Undergraduate Research Fellowships (SURF) Program 2008 - 2009

Awards

Karl-Lark Horowitz Award for Outstanding Research Accomplishment, 2012

Established in 1969. The highest award given to graduate students by Physics Department at Purdue University

Grodzins Summer Research Award, 2008

Established in 2003 to provide support of graduate students engaged in research during the summer term

First prize of Best Gen-Nano Game Competition, 2008

Hosted by Network for Computational Nanotechnology and nanoHUB.org

Publications

Peer-reviewed Journal Publications:

1. H. Cao, J. Tian, I. Mitkowski, T. Shen, J. Hu, S. Qiao and Y. P. Chen, "Quantized Hall Effect and Shubnikov-de Hass Oscillations in highly doped Bi_2Se_3 : Evidence for Layered Transport of Bulk Carriers", **Physical Review Letters** **108**, 216803 (2012)
2. H. Cao, Q. Yu, L. Jauregui, J. Tian, W. Wu, Z. Liu, R. Jalilian, D. K. Benjamin, Z. Jiang, J. Bao, S. S. Pei and Y. P. Chen, "Electronic Transport in Chemical Vapor Deposited Graphene Synthesized on Cu: Quantum Hall Effect and Weak Localization", **Applied Physics Letters** **96**, 122106 (2010)
3. H. Cao, Q. Yu, R. Colby, D. Pandey, C. S. Park, J. Lian, D. Zemlyanov, I. Childres, V. Drachev, E. A. Stach, M. Hussain, H. Li, S. S. Pei, and Y. P. Chen, "Large-scale Graphitic Thin Films Synthesized on Ni and Transferred to Insulators: Structural and Electronic Properties", **Journal of Applied Physics** **107**, 044310 (2010)
4. Q. Yu, L. A. Jauregui, W. Wu, R. Colby, J. Tian, Z. Su, H. Cao, Z. Liu, D. Pandey, D. Wei, T. F. Chung, P. Peng, N. Guisinger, E. A. Stach, J. Bao, S. S. Pei and Y. P. Chen, "Control and characterization of individual grains and grain boundaries in graphene grown by chemical vapour deposition", **Nature Materials** **10**, 443 (2011)
5. J. Tian, H. Cao, W. Wu, Q. Yu and Y. P. Chen, "Direct Imaging of Graphene Edges: Atomic Structure and Electronic Scattering", **Nano Letters** **11**, 3663 (2011)
6. J. Cho, L. Gao, J. Tian, H. Cao, W. Wu, Q. Yu, E. N. Yitamben, B. Fisher, J. R. Guest, Y. P. Chen, and N. P. Guisinger, "Atomic-Scale Investigation of Graphene Grown on Cu Foil and the Effects of Thermal Annealing", **ACS Nano** **5**, 3607 (2011)
7. J. Tian, H. Cao, W. Wu, Q. Yu, N. P. Guisinger and Y. P. Chen, "Graphene Induced Surface Reconstruction of Cu", submitted (2012)
8. X. Liu, D. J. Smith, H. Cao, Y. P. Chen, J. Fan, Y. H. Zhang, R. E. Pimpinella, M. Dobrowolska-Furdyna, and J. K. Furdyna, "Characterizations of Bi_2Te_3 and Bi_2Se_3 topological insulators grown by MBE on (001) GaAs substrates", **Journal of Vacuum Science and Technology B** **30**, 02B103 (2011)
9. X. Liu, D. J. Smith, J. Fan, Y. H. Zhang, H. Cao, Y. P. Chen, J. Leiner, B. Kirby, M. Dobrowolska-Furdyna and J. K. Furdyna, "Structural properties of Bi_2Te_3 and Bi_2Se_3 topological insulators grown by molecular beam epitaxy on GaAs(001) substrates", **Applied Physics Letters** **99**, 171903 (2011)
10. A. N. Sidorov, A. Sherehiy, R. Jayasinghe, R. Stallard, D. K. Benjamin, Q. Yu, H. Cao, W. Wu, Z. Liu, J. Bao, S. S. Pei, Y. P. Chen, Z. Jiang and G. U. Sumanasekera, "Thermoelectric power of CVD grown graphene as surface charge doping indicator", **Applied Physics Letters** **99**, 013115 (2011)
11. L. A. Jauregui, H. Cao, W. Wu, Q. Yu and Y. P. Chen, "Electronic properties of grains and grainboundaries in graphene grown by chemical vapor deposition", **Solid State Communications** **151**, 1100 (2011)
12. J. Qi, X. Chen, W. Yu, P. Cadden-Zimansky, D. Smirnov, N. H. Tolk, I. Miotkowski, H. Cao, Y. P. Chen, Y. Wu, S. Qiao and Z. Jiang, "Ultrafast carrier and phonon dynamics in Bi_2Se_3 crystals", **Applied Physics**

Letters **97**, 182102 (2010)

13. W. Wu, Z. Liu, L. A. Jauregui, Q. Yu, J. Bao, R. Pillai, H. Cao, Y. P. Chen and S. S. Pei, “Wafer-scale Synthesis of Graphene by Chemical Vapor Deposition and its Application in Gas Sensing”, **Sensors and Actuators B** **150**, 296 (2010)
14. R. Colby, Q. Yu, H. Cao, S. S. Pei, E. A. Stach and Y. P. Chen, “Cross-sectional transmission electron microscopy of thin graphite films grown by chemical vapor deposition”, **Diamond and Related Materials** **19**, 143 (2010)
15. J. Tian, L. A. Jauregui, G. Lopez, H. Cao, and Y. P. Chen, “Ambipolar Graphene Field Effect Transistors by Local Metal Side Gates”, **Applied Physics Letters** **96**, 263110 (2010)
16. D. Pandey, G. Prakash, Q. Yu, H. Cao, L. A. Jauregui, S. S. Pei and Y. P. Chen, “Surface Microscopy Characterizations of Large Size Graphene films Grown by Surface Segregation on Ni and Transferred to Si/SiO₂ Substrate”, **ECS Transactions** **19**, Issue 5, 75 (2009)
17. L. Zhang, J. Camacho, H. Cao, Y. P. Chen, M. Khodas, D. Kharzeev, A. Tsvetik, T. Valla and I. A. Zaliznyak, “Breakdown of the N=0 Quantum Hall State in graphene: two insulating regimes”, **Physical Review B** (Rapid Communications) **80**, 241412 (2009)
18. H. Y. Fan and H. Cao, “New normally ordered four-mode squeezing operator for standard squeezing of four-mode quadratures”, **Communications in Theoretical Physics** **47**, 135 (2007).

Conference Presentations:

Refereed Plenary Talks:

- “Bulk quantum Hall effect and SdH oscillation of 2D carriers in Bi₂Se₃”, 19th International Conference on Electronic Properties of Two-Dimensional Systems, Jun. 2011 (Tallahassee, FL)
- “Magneto-transport and quantum oscillation in Bi₂Se₃”, Physical Phenomena at High Magnetic Fields VII, Dec. 2010 (Tallahassee, FL)

Refereed Conference Presentations:

- “Transport properties of topological insulator materials”, Correlated Electron Systems Gordon Research Conference, Jun. 2012 (South Hadley, MA)
- “High mobility ambipolar field effect transistors made from large-scale CVD graphitic thin films”, 67th Device Research Conference, Jun. 2009 (University Park, PA)
- “Electronic properties of large-scale graphene chemical vapor synthesized on nickel and on copper”, TECHCON Conference, Sep. 2009 (Austin, TX)

American Physical Society March Meeting Presentations:

- “Gate-tunable electronic transport in topological insulator Bi₂Se₃ thin films synthesized by metalorganic chemical vapor deposition”, 2012 (Boston, MA)
- “Quantum oscillations and quantum Hall effect in topological insulator material Bi₂Se₃”, 2011 (Dallas, TX)
- “Electronic properties of CVD graphene grown on copper”, 2010 (Portland, OR)
- “Electronic properties of large-scale graphene chemical vapor synthesized on nickel and on sapphire”, 2009 (Pittsburgh, PA)