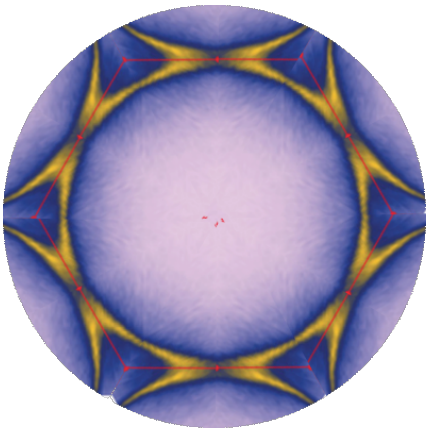
Postdoctoral Fellowship Highlight

Jessica L. McChesney, Ph.D., Physics

Years of Fellowship: 2007-2010
Collaborating Institution: Montana State University
Currently: Staff Scientist, Advanced Photon Source

Project: **Interactions of graphene with adsorbates**

Graphene, a single layer of carbon atoms arranged in a honeycomb, is one of the most attractive new materials to be discovered in recent years. Among its incredible properties, it has remarkably high tensile strength and electronic mobility. Furthermore, its electronic structure can be easily tailored and a variety of new device schemes have been proposed based on graphene. It also has fascinating properties of interest to fundamental physics, the most famous of which is that electrons in graphene propagate as though they were massless fermions.



Jessica came to the ALS through a joint fellowship established between the ALS (E. Rotenberg) and Montana State University (Prof. G. Lapeyre, funded by EPSCOR) for the study of low dimensional materials and semiconductors. Her first project was to assist in a major rebuild of the Angle Resolved Photoemission Spectroscopy (ARPES) apparatus, followed by a very productive period in which she co-authored several high-profile papers.

Graphene, an up-and-coming material at the time, quickly took center stage, and Jessica was in charge of a very difficult project: to electron-dope graphene as heavily as possible to study its electronic structure near the Van Hove singularity. This work was done in close collaboration with two other fellows, A. Bostwick and T. Ohta. Doping graphene to such a high level (few times 1014 cm-2) greatly enhances the attractive interactions, favoring superconductivity. This work achieved the highest doping level of any graphene short of embedding the material in polymer electrolyte, and thus constituted the only such material that can be studied by surface techniques [1].

Jessica single-handedly organized an outside collaboration with R. Bennewitz (University of Saarbrucken) for the first determination of tribological (friction properties) of graphene. His research showed that a significant difference in friction between single and monolayer graphene

could be attributed to a notable difference in the electron-phonon coupling that can be measured with ARPES [2].

Jessica made major contributions to a third graphene paper, in which the defect density of graphene could be varied, up until a metal-insulator transition was induced. This transition was attributed to Anderson localization, and was the first example where such a transition could be studied in ARPES in a crystalline material [2].

In addition, Jessica was a frequent participant in outside user projects, which led to several notable papers [4-7]. After her fellowship at the ALS, Jessica was hired as a beamline scientist at the Advanced Photon Source, where she is currently building a new beamline for ARPES at high photon energies.

[1] McChesney, J. L. et al. Extended van Hove Singularity and Superconducting Instability in Doped Graphene. *Physical Review Letters* **104**, 136803 (2010).

[2] Filleter, T. et al. Friction and Dissipation in Epitaxial Graphene Films. *Phys. Rev. Lett*. **102**, 086102–086104 (2009).

[3] Bostwick, A. et al. Quasiparticle Transformation During a Metal Insulator Transition in Graphene. *Phys. Rev. Lett*. **103**, 056404–1–4 (2009).

[4] Hossain, M. et al. In situ doping control of the surface of high-temperature superconductors. *Nat Phys* **4**, 527–531 (2008).

[5] Fournier, D. et al. Loss of nodal quasiparticle integrity in underdoped $YBa_2Cu_3O_{6+x}$. *Nature Physics* **6**, 905–911 (2010).

[6] Meyer, S. et al. Strictly one-dimensional electron system in Au chains on Ge(001) revealed by photoelectron k-space mapping. *Physical Review B* **83**, 121411 (2011).

[7] Liu, C. et al. K-Doping Dependence of the Fermi Surface of the Iron-Arsenic $Ba_{1-x}KxFe_2As_2$ Superconductor Using Angle-Resolved Photoemission Spectroscopy. *Physical Review Letters* **101**, 177005 (2008).

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