Volume 12

Washington University
Undergraduate Research Digest

Spring 2017

Lighter Than a Feather: MEMs Scale with Attogram Sensitivity

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Lighter Than a Feather: MEMS Scale with Attogram Sensitivity

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An ongoing project in the Henriksen lab explores the effect of adding isolated osmium atoms to the surface of devices based on flakes of graphene. This is done in order to determine if osmium can induce a spin-orbit coupling in graphene, in the hope of eventually creating a 2D topological insulator. There is much current interest in the study of topological insulators, which exhibit bulk insulator and conducting edge states, very similar to the Quantum Hall Effect but occurring at zero magnetic field instead of the quantizing fields required in the QHE.

In this process, it is critical to know the density of atoms added to the graphene, but directly measuring such a tiny added mass is difficult. For atoms that interact electronically by donating charge to graphene, the number of atoms added to the lattice can be easily determined by measuring the shift in the charge neutrality point of graphene against an applied gate voltage, but this technique cannot work for atoms that remain neutral. Therefore, in order to measure the density of added atoms, we attempted to construct microelectromechanical (MEMS) resonators from silicon-on-insulator wafers. Such resonators, in a parallel plate capacitor configuration, exhibit resonant frequencies that can be measured electronically. When atoms are added to the silicon device layer, the resonant frequency of the device changes due to mass loading, and this change in resonant frequency can be directly related to the change in mass. By placing this resonator some distance from a source of mass (in this case, a small thermal evaporator located near the sample stage in the measurement cryostat), the mass flux from the source can be measured, and the number of atoms added to the graphene can be determined. These resonators have sizes on the order of magnitude of about 500 microns.