Magnetic Properties of Aligned, Single Chirality Carbon Nanotube Films

ABSTRACT: Graphite is readily known as one of the strongest diamagnetic materials in nature. For any graphene allotropes with similar benzene structure, like many carbon nanomaterials, it has also been found that they exhibit strong diamagnetism. Carbon nanotubes (CNTs) are a class of nanomaterial derived from atomically thin layers of sp2 carbon rolled into hollow cylinders with diameters on the nanoscale (< 1 nm to 20 nm). The chirality, or the arrangement of the carbon atoms along the nanotube, determines their attractive physical properties such as their high electrical conductivity, thermal stability and optical characteristics. The magnetic properties of single-walled carbon nanotubes (SWNTs) – both metallic and semiconducting species – change with the direction of the magnetic field with respect to the tube axis, yielding a magnetic anisotropy given by \( \Delta \chi = \chi_{//} - \chi_{\perp} \). Metallic SWNTs are paramagnetic along the tube axis (\( \chi_{//} > 0 \)) and diamagnetic in the perpendicular direction (\( \chi_{\perp} < 0 \)), whereas semiconducting tubes are diamagnetic in all directions (\( \chi_{//}, \chi_{\perp} < 0 \)). Our previous magnetic linear dichroism spectroscopy measurements also found that metallic SWNTs do not follow strict diameter dependence across the 7 chiralities present in our sample. We are currently pursuing direct measurement of the magnetization in aligned, single chirality SWNT films at room temperature. We expect that this and future results on other chiralities will not only determine the true diameter dependence of the magnetic properties of SWNTs but they will also yield exact numbers for the difference in susceptibility for specific chiralities for the first time.

BIO: Thomas A. Searles received his Ph.D. in the Applied Physics in the Electrical & Computer Engineering Department at Rice University in 2011. His thesis work primarily focused on the magnetooptical properties of carbon nanotubes. Upon his appointment at Howard in the Fall of 2015, Prof. Searles has established a new research program in applied and materials physics. In particular, the Searles Applied & Materials Physics Laboratory (SAMPL) is exploring the optical, electrochemical, magnetic and electron emission properties of electronic type-sorted single-walled carbon nanotube films. During his career, Thomas has performed experiments at the National High Magnetic Field Laboratory, Naval Research Laboratory, UCSB Free Electron Laser Facility, National Institute of Materials Science (Tsukuba, JP) and Tohoku University (Sendai, JP). Furthermore, he has completed Visiting Faculty Fellowship appointments at Los Alamos National Laboratory and the Air Force Research Laboratory. Thomas graduated from Morehouse College with a B.S. in Mathematics and Physics. He is a native of Albany, GA.

The Physics Department Seminar Series presents…

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Prof. Thomas A. Searles

Tuesday, April 12th
4:00 reception,
4:15 presentation
Cleveland L3

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