DIAMETER DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY ANISOTROPY IN METALLIC CARBON NANOTUBES

T. A. Searles[1], E. H. Haroz[1], Y. Imanaka [2], T. Takamasu [2], and J. Kono[1]
[1]Department of Electrical & Computer Engineering, Rice University, Houston, TX, U.S.A
[2]National Institute for Materials Science, Tsukuba, Japan

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 nanotubes 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 ($\chi_{//}$, $\chi_{\perp} < 0$). This anisotropy of magnetic susceptibilities results in the nanotubes in solution aligning as the magnetic field is increased. This, combined with the anisotropic optical absorption properties of SWNTs, allows for the use of polarization-dependent optical absorption to measure the degree of alignment through magnetic linear dichroism (MLD) spectroscopy. Our previous MLD measurements on a length-sorted, (6,5)-enriched CoMoCAT SWNT suspension found that the (6,6), (5,5), and (7,4) nanotubes align more rapidly with the magnetic field than semiconducting nanotubes found in our sample [1].

As a complementary experiment, here we investigated a metallic-enriched HiPco SWNT sample [2] that was selected not only for its larger population of metallic species relative to our previous sample but its specific enrichment in armchair, or (*n*,*n*), carbon nanotubes. Utilizing the 35 T Hybrid Magnet in the High Magnetic Field Facility of the National Institute for Materials Science in Tsukuba, Japan, we measured absorption with light polarization both perpendicular and parallel to the magnetic field to determine MLD. By relating these values with the nematic order parameter for alignment, we found that the metallic carbon nanotubes do not follow a strict diameter dependence across the 7 chiralities present in our sample.

This work was supported by the DOE-BES (Grant No. DE-FG02-06ER46308), the NSF (Grants No. OISE-0530220 and No. OISE-0968405), and the Robert A. Welch Foundation (Grant No. C-1509).

References

[1] T. A. Searles *et al*., Phys. Rev. Lett. **105**, 017403 (2010).
[2] E. H. Hároz *et al*., ACS Nano **4**, 1955 (2010).