MAGNETIC SUSCEPTIBILITY ANISOTROPY OF METALLIC SINGLE-WALLED CARBON NANOTUBES

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Through polarization-dependent magneto-absorption spectroscopy we have extracted the magnetic susceptibility anisotropy for metallic single-walled carbon nanotubes (SWNTs) and found it to be much larger than that of semiconducting SWNTs. The magnetic properties of 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. Previous MLD studies on HiPco semiconducting nanotubes found that $\Delta\chi \bullet 1.4 \times 10^{-5}$ emu/mol, but there was no information on $\Delta\chi$ for metallic nanotubes. Our measurements on length-sorted, (6,5)-enriched CoMoCAT SWNTs were made using the 35 T Hybrid Magnet in the High Magnetic Field Facility of the National Institute of Materials Science in Tsukuba, Japan. We measured absorption with light polarization both perpendicular and parallel to the magnetic field to determine the MLD. By relating these values with the nematic order parameter for alignment *S*, we found that the (6,6), (5,5), and (7,4) nanotube aligns more rapidly with the magnetic field than semiconducting nanotubes found in our sample.