Magnetic Properties of Carbon Nanofoam

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Ferromagnetism is typically the property of transition metals where there are unpaired electrons in unfilled atomic shells even in the solid. Nevertheless various form of carbon show ferromagnetic or ferromagnetic-like behaviour such as the purely organic ferromagnet TDAE-C_{60} [1], polymerized C_{60} forms [2], hydrogenated amorphous carbon [3] and cluster assembled carbon nanoform [4]. This system which has an ultra-low density (2-10 mg/cm3) is obtained by laser ablation of glassy carbon in an argon atmosphere [4, 5]. In carbon nanofoam a large difference between field cooled (FC) and zero field cooled (ZFC) magnetic susceptibility has been observed (5). Some samples show a maximum in the magnetic susceptibility between 50 K and 100 K characteristic of spin-glasses. A weak ferromagnetic like hysteresis curve has been observed at 2 K between 5 T and - 5 T with a saturation magnetization of MS 0.3 emu/g. Proton NMR measurements on absorbed water at room temperature showed the existence of two components in the magnetization decay. One has a T1 of about 0.8 msec and the other of about 200 msec. This demonstrates the inhomogeneous nature of the magnetization in carbon nanofoam with magnetic island embedded in a non-magnetic medium. Similar results are also obtained by EPR where three different well separated magnetic centers with different T1 values have been observed.

NOVEL ROUTE TO (BIO)-POLYMER NANOTUBE COMPOSITES

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Novel polymer nanotube composites were fabricated by intercalating either polyvinylpyrrolidone (PVP) as a reference material and various biopolymers into carbon nanotube architectures from solution. This was carried out for both low (10k g/mol) and very high (1.3M g/mol) molecular weight polymers into buckypaper, fibres or stand-alone forests. Measurements of the polymer mass uptake as a function of time allowed the calculation of diffusion co-efficients for the various polymer and biopolymer strands respectively. Comparison of these co-efficients suggests that each polymer type undergoes a different mode of diffusion: normal diffusion for the low molecular weight polymers, but reptation for the high molecular weight polymers. This means that while the low weight polymer retains its randomly coiled conformation during diffusion and adsorption, the high weight polymer is forced to adopt an extended, high entropy state. These differences are reflected in the mechanical properties of the intercalated architectures. While reinforcement was observed in all cases, modulus (increase up to ≈3.5x) and strength (≈6x) enhancement were more efficient for the longer chain polymers. However the architectures intercalated with the shorter chain molecules were much tougher (≈25x). This novel route to tailored mechanical properties could be expected to be applied to any nanomaterial composite.

PHOTOLUMINESCENCE MAPPING OF VARIOUS (N, M) NANOTUBES BY CROSS-POLARIZED ABSORPTION

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Photoluminescence excitation (PLE) spectroscopy of single-walled carbon nanotubes (SWNTs) have been extensively studied for characterization of their unique electronic properties. In this report, we have studied polarized PLE spectra of various (n, m) nanotubes in surfactant suspension. Using a simple theory for PL anisotropy, we have obtained decomposed-PL maps for parallel and perpendicular polarization from two PL maps measured by so-called L-format method [1]. For some (n, m) nanotubes, distinct peak splitting of E12 and E21 transitions for perpendicular polarization was observed. Average of observed E12 and E21 energies was considerably larger than average of E11 and E22, although the average of E12 and E21 should give close agreement with that of E11 and E22 within tight-binding calculation of SWNT considering geometry optimization and curvature effect [2]. This qualitative discrepancy between measurement and calculation indicates the different amount of excitonic effect for each state. Detailed experimental techniques and results will be discussed.

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