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Ferromagnetic gamma-Fe Nanoparticles Trapped in Carbon Nanotubes MUTSUHIRO SHIMA, BINGQING WEI, RANJIT PATI, SAROJ NAYAK, PULICKEL AJAYAN, Rensselaer Polytechnic Institute, Troy NY, SABURO NASU, Osaka University, Japan — It is known that iron exists in different allotropic forms, where at ambient conditions the most stable phase is ferromagnetic body-centered cubic, and the face-centered cubic (fcc) phase (gamma-Fe) is thermodynamically unstable and not ferromagnetic. However, theoretical studies have predicted the existence of two different magnetic states in gamma-Fe, i.e. high-spin and low-spin state, depending on the inter-atomic distance in the fcc lattice. We have found that iron catalyst nanoparticles trapped in carbon nanotubes are indeed ferromagnetic gamma-Fe at room temperature. The unusual magnetic moment of gamma-Fe nanoparticles observed using room temperature magnetic measurements and Mossbauer spectroscopy is explained by a lattice expansion due to insertion of carbon atoms into the interstitial sites. According to the Mossbauer data analysis, there exist two different magnetic moments of iron in the gamma-Fe nanoparticles, presumably due to their atomic environments, namely whether they have a carbon atom in the nearest neighbor or not. The First principles calculations corroborate that ferromagnetism observed here is related to both lattice distortion and charge transfer between iron and carbon atoms. Detailed analysis of the structure and magnetic properties of the magnetic clusters will be discussed.

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