Separation of intrinsic and extrinsic contribution to fullerene magnetism

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Magnetic and structural properties of pressure-polymerized fullerenes have been systematically studied by means of SQUID magnetometry, electron spin resonance, X-ray diffractometry, Raman spectroscopy, high resolution inductive coupled plasma mass spectrometry. Experimental samples have been synthesized from commercially available C_{60} powders with low content of ferromagnetic metals (Fe=1.2, Ni=0.05, Co=0.002, Mn=0.03, Cr=0.01 mg/kg) impurities. Synthesis have been carried out at several pressure values in the temperature range 600-1050^{o}C and time of heating 1-17 min using two types of assembling high pressure cells: with electrical insulating polycrystalline hexagonal BN container and without electrical insulating cover.

This difference in preparation conditions results in colossal structural difference between the samples prepared at nominally identical conditions.

We have found that iron can penetrate during the high pressure-high temperature synthesis from steel environment, and its content in the ready samples varies from 1.5 to 46 mg/kg without any correlation with the synthesis pressure and temperature. On the contrary, the nonlinear contribution to magnetization increases with the synthesis temperature without any correlation to the iron content. It is tempting to assign this effect to the intrinsic carbon magnetism. However, the magnetization values are small, and this trend can equally be attributed to the clusterization of iron atoms with the possible formation of the iron carbides.

On the other hand, for several samples the magnetization values 10–20 times increased those expected from the metallic contamination. The process of depolymerization of these samples was followed in situ by ESR, and we observed dramatic changes in the EPR signals, Raman spectra and X-ray patterns, whereas the magnetization values dropped several times. Thus, the additional magnetic signal is directly connected with the polymerized fullerene phase and cannot be attributed to the carbides.