Magnetism of C_{60} induced by polymerization

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C_{60} and the other fullerenes exhibit both diamagnetic and paramagnetic ring currents, paramagnetic ring currents being associated with pentagons. The magnetic susceptibility of C_{60} was first experimentally measured in 1991, and the diamagnetism of C_{60} was found to be relatively small. This result was attributed to excited-state paramagnetic contributions to the π-electron ring-current magnetic susceptibility. We show that the magnetic properties are strongly enhanced in the neutral (undoped) C_{60} polymers, where paramagnetic behavior is observed. Fig.1 presents the AC susceptibility measurements performed on neutral (a), photopolymerized (b) and pressure-polymerized samples (c), and indicates that polymerization at certain conditions may change the sign of the magnetic response.

AC susceptibility of the pristine fullerene powder at temperatures above 8 K is negative and almost temperature independent. At low temperatures the absolute value of susceptibility decreases and even changes its sign, showing weak paramagnetism at 2 – 4 K due to the superimposed Curie-like term which is usually attributed to intercalated oxygen. In contrast to pristine C_{60}, the magnetization of polymerized C_{60} is positive, but it shows a similar upturn at the same temperature. The absolute value of susceptibility is twice larger for the photopolymers, and is even more for the pressure-polymers. When allowance is made for the superimposed Curie term, the susceptibility of polymerized fullerenes increases slightly with temperature.

For the samples prepared at the predetermined conditions, hysteresis curves were observed with a clear Curie point at 500 K [1]. Fig. 2 shows the results for the samples prepared at identical conditions, but at temperatures of 1023 K (1) and 1073 K (2). The small values of saturation magnetization indicate that only a small part of the sample contributes to ferromagnetism. To determine any inorganic ferromagnetic impurities, the samples were decomposed and subjected to analysis by atomic absorption spectroscopy which revealed less than 20 ppm of Fe, 10 ppm of Ni and absence of Co.

1. T.L. Makarova, B. Sundqvist, P. Esquinazi, R. Höhne, Y. Kopelevich, P. Scharff, V. A. Davydov, L. S. Kashevarova, and A. V. Rakhmanina. Magnetic carbon. *Nature* **413** 716 – 718 (2001).

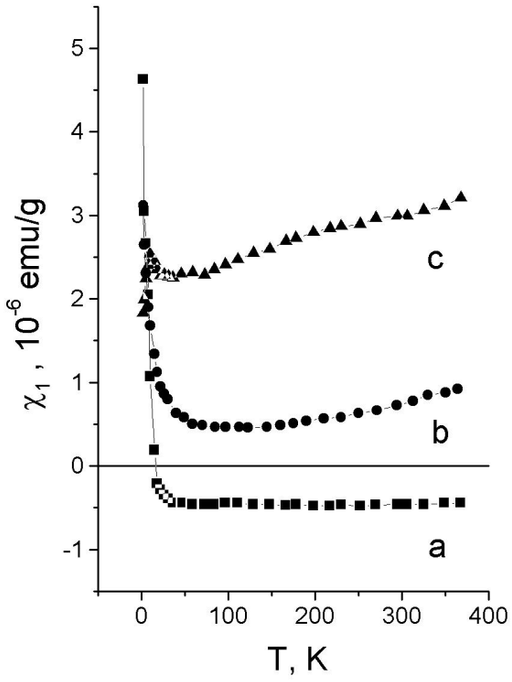

Fig.1. AC susceptibility of pristine (a), photopolymerized (b) and pressure-polymerized (c) C_{60}.

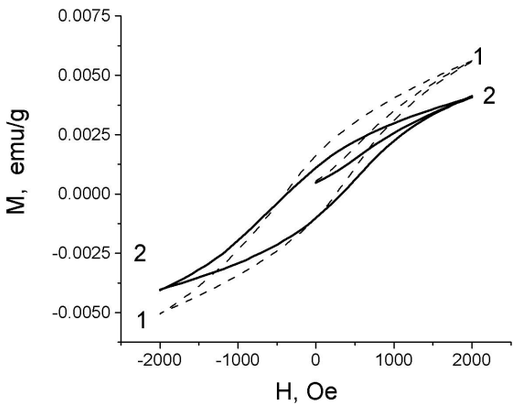

Fig.2. M versus H at 300 K for two samples of pressure-polymerized C_{60}