

Magnetism in metal-free phthalocyanine and graphite-like nanostructuresArmen N Kocharian¹, Eduard Sharoyan², Armen Mirzakhanyan², Harutyun Gyulasaryan², Carlos Sanchez¹, Oscar Bernal¹, Aram Manukyan² and Michail C Goff¹¹California State University, USA²National Academy of Sciences of Armenia, Armenia

From the point of view of both fundamental science and practical applications, of great interest is high-temperature ferromagnetism, observed in various carbon-based materials. Carbon microspheres with interesting magnetic properties have been fabricated by the solid-phase pyrolysis of a metal-free phthalocyanine $H_2Pc=H_2(C_{32}N_8H_{16})$ used as a precursor. By changing the conditions of pyrolysis, we prepared carbon microspheres with a mean diameter 2-3.8 μm consisting of (layered graphite) graphitized nanocrystallites and amorphous carbon with a thickness of 5-15 graphene layers and width of 5-20 nm and sufficiently narrow size distribution. In particular, at $T_{pyr}=700^\circ C$ and $t_{pyr}=30$ min, we obtained carbon microspheres with a mean diameter $d=3.4\pm 0.15 \mu m$. The comparison of magnetic properties in metal-free phthalocyanine and graphite-like nanostructures is provided in the broad range of temperatures and magnetic fields. Magnetic characteristics of these samples were investigated with a vibrational magnetometer in the temperature range 5-300 K, as well as with electron spin resonance (ESR) spectroscopy. Analysis of curves M-T and M-H shows the presence of paramagnetic centers with the concentration $n=3\cdot 10^{19}$ spin/g and temperature-independent diamagnetism with susceptibility of $\chi^{Dia}=1.2\cdot 10^{-6}$ emu/g-Oe. The parameters of ESR spectrum were measured at 300K: the g-factor 2.0031 and intensity $\sim 5\cdot 10^{19}$ spin/g. The ESR line width is only 0.8 Oe which indicates a strong exchange narrowing. Along with the paramagnetic centers and diamagnetism, we have revealed ferromagnetic hysteresis loops from T=5 K to room temperature. The dependences of magnetizations of diamagnetic and ferromagnetic signal on H at T=300K are presented in figures below. The maximum value of coercive force is 150 Oe at T=300K. We also analyze the nature of the reported evidence on superparamagnetism, diamagnetism and ferromagnetic ordering in the metal-free phthalocyanine and metal-free pyrolytic carbon structures containing only p- and s-electrons.

Biography

Armen N Kocharian has an expertise in the field of magnetism and electron instabilities in low dimensional systems. He has completed his PhD at the Moscow State University in Moscow, 1977 and DSc in Yerevan Physics Institute, 1991. He has published more than 125 papers in reputed journals. He is a Member of Editorial Board of the *International J. on ISRN Condensed Matter* (2011), *Peer reviewer in Materials Letters* (2015), *J. Magn. & Magn. Materials* (2015), *Phys. Chemistry Chemical Physics* (2014), *RSC Advances* (2014), *J. of Nanoparticle Research* (2012).

armen.kocharian@calstatela.edu**Notes:**