

The design of ionic complexes of fullerenes manifesting high conductivity and coexistence of high conductivity and magnetic interactions

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Donor-acceptor complexes of fullerenes can possess high conductivity including metallic conductivity and superconductivity, and manifest ferromagnetic and antiferromagnetic interaction of spins. One of the promising tasks in the field of the design of functional fullerene compounds is the preparation of compounds in which high conductivity coexists with magnetic interaction of spins.

Multi-component ionic complex, (MDABCO⁺)·(C₆₀^{•-})·TPC (MDABCO⁺ is the cation of *N*-methyldiazabicyclooctane; TPC is triptycene) were obtained. The complex has layered structure, in which closely packed hexagonal fullerene layers alternate with the layers composed of TPC and MDABCO⁺. Two types of fullerene layers exist with different environment and rotation freedom of C₆₀^{•-} (fullerenes are ordered in one layer and are disordered in another). Complex is an unique pure organic quasi-two dimensional metal with unusual properties. The coexistence of metallic layers with non metallic layers having antiferromagnetic interaction of spins is observed in the 200-360K range. Non metallic layers transfer to the metallic state below 200K due to the ordering of C₆₀^{•-}. Below 183K the structural transition is realized resulted in the appearance of conductivity anisotropy in the fullerene layers. The effect of the cation substitution on the structure and properties of the complexes is discussed.

Fullerene C₆₀ salts with *d*- and *f*-metal cations: (C₆₀^{•-})₂·{(M²⁺)·(DMF)_x} (M = Co, Fe, Ni, Mn, Eu and Cd; DMF: *N,N*-dimethylformamide; x = 2.4 – 4) were obtained [1]. The salts possess high conductivity at room temperature (RT) (1-125 S·cm⁻¹) and show semiconducting temperature dependence of resistivity with small activation energy (300-1200K). Salts with Co²⁺, Fe²⁺ and Ni²⁺ manifest also rather strong antiferromagnetic interaction of spins. As a result EPR signal from C₆₀^{•-} strongly broadened at temperature decrease (from 40-100 G at RT to 400-600 G at 4K). Fullerenes form diamagnetic single-bonded (C₆₀⁻)₂ dimers in the salts with Mn²⁺ and Eu²⁺ resulting in the decrease of magnetic moment of the complex and the disappearance of EPR signal from C₆₀^{•-}. The C₆₀^{•-} radical anions are magnetically isolated in a salt with the diamagnetic Cd²⁺ cation. However, this salt shows rather high conductivity.

[1] Konarev, D.V., Lyubovskaya R.N. *Izvestiya RAN, Ser. Khim.*, 1909 (2008).