New organic and hybrid (organic-inorganic) electroactive materials and nanomaterials of tunable electronic, magnetic and optical properties

Among the plethora of organic compounds "organic metals" and "organic semiconductors" distinguish themselves by physical and technological properties unmatched by other compounds. Organic semiconductors offer several advantages over their inorganic counterparts: 1) their physical properties can be highly anisotropic; 2) their electrical optical and magnetic properties can be smoothly tuned by appropriate functionalization; 3) they can be processed from solution. For these reasons organic semiconductors found applications in such electronic devices as field effect transistors, light emitting diodes, photodiodes, photovoltaic cells and others, as well as in electrochemical devices as electrochromophores.

The main goal of this project is the design, synthesis and characterization of new purely organic semiconductors and magnetic materials, as well as luminescent hybrids consisting of inorganic and organic components. **An important scientific novelty proposed here is to use various interactions such as electrostatic dipole moment, ferromagnetic spin-spin and charge transfer intramolecular interactions to improve electronic, magnetic, photovoltaic and luminescent properties of the designed materials.** In the design of these new compounds three types of interactions will be exploited:

1) electrostatic interactions – we will study the effect of the intentional incorporation of an organic moiety bearing a dipole moment into macromolecules of potential interests on their physical properties, including photovoltaic ones;

2) magnetic interactions – the effect of the intentional incorporation of spin coupling units into conjugated macromolecules will be studied with the aim of the elaboration of purely organic high-spin materials;

3) charge and energy transfer interactions – we will elaborate and study new low and high molecular mass organic donor–acceptor compounds of tunable band gap and luminescence by combining the same donor with acceptors of increasing strength. This should lead to semiconductors of decreasing band gaps and emission changing from red to infrared part of the spectrum.

Organic-inorganic hybrids will also be investigated in which the energy of a photon absorbed by a semiconductor nanocrystal will be upconverted to a photon of higher energy through energy transfer to an organic luminophore *via* a transmitting ligand.

Theoretical calculations will be used in the design of all studied compounds. They will be then synthesized using typical organic synthetic methods, exploiting, for example, palladium - catalyzed C-C coupling. Their characterization will involve spectroscopic, electrochemical, diffraction and magnetic methods. They will also be tested as components of electronic devices (light emitting diodes, photodiodes, field effect transistors and others), as spintronic materials as well as components of electrochromic layers.