Synthesis and application of Carbon Nanodots

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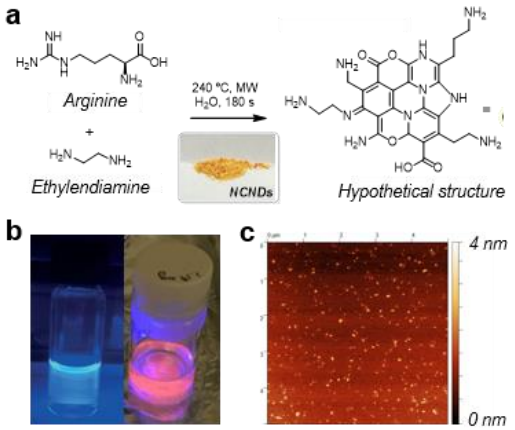
This project is focused on Carbon Nanodots, the latest member of the carbon nanomaterials family. Applications include photo- and electro-catalysis, drug delivery and contrast agents.

Carbon Nanodots are carbon-based quasi-spherical nanoparticles with size below 10 nanometres. In contrast with other carbon-based nanomaterials they show good water solubility and are fluorescent; moreover, they have low toxicity. These features make them suitable for both technological and biological applications.

Our group is particularly interested in the chemistry of carbon nanodots, from the investigation and engineering of their properties, up to their application. Examples are the study of core and surface properties (including electrochemical and chiral properties), the engineering of fluorescence, and the use of carbon nanodots in light-emitting devices, as organo- and photo-catalysis, and as drug carriers.[1]



Carbon Nanodots: (**a**) typical synthetic strategy; (**b**) blue and red-emitting carbon nanodots; (**c**) AFM image of the studied material.

The synthesis of this material is typically performed with a simple and inexpensive microwave reaction.[2] In this process, different organic precursors are chosen (e.g. amino acids, small aromatic and aliphatic molecules) to tailor the properties of the target material.

The PhD student will develop both synthetic and instrumental skills. The synthesis of small molecules, as well as carbon nanodots will be performed. The obtained materials will be analysed with state-of-the-art spectroscopic methods, including nuclear magnetic resonance (NMR), optical spectroscopies, atomic force microscopy (AFM), transition electron microscopy (TEM) and infrared spectroscopy (IR). Our group has also a strong track record of fruitful collaborations, that involve also the use of X-ray facilities at the synchrotron (Trieste) or at CIC biomaGUNE (San Sebastian, Spain). For the optimal development of collaborative projects, it is likely for PhD students to perform a research stay abroad.

Currently, seven members of the group are involved in this frontier research line, thus creating a lively and stimulating environment for the professional development of new members. Our group is committed to interdisciplinarity and the student will be exposed also to other fields related to carbon nanomaterials, that represent the group core expertise.

Typically, the PhD work starts from a project that is ongoing in the group. Then, the individual interests and attitudes of the student come into play and shape the development of their path into research.

References:

[1] For selected examples see: (a) “Design principles of chiral carbon nanodots help convey chirality from molecular to nanoscale level”, L Đorđević, F Arcudi, A D’Urso, M Cacioppo, N Micali, T Bürgi, R Purrello, M. Prato, *Nature Commun.* **2018**, 9, 3442; (b) “Customizing the Electrochemical Properties of Carbon Nanodots by Using Quinones in Bottom-Up Synthesis” F Rigodanza, L Đorđević, F Arcudi, M Prato, *Angew. Chem. Int. Ed.* **2018**, 57, 5062-5067.

[2] “Synthesis, Separation, and Characterization of Small and Highly Fluorescent Nitrogen-Doped Carbon NanoDots” F Arcudi, L Đorđević, M Prato, *Angew. Chem. Int. Ed.* **2016**, 55, 2107-2112.