Carbon nanostructures: synthesis, functionalization, characterization, and their applications

Supervisor: Tatiana Da Ros (University of Trieste)

The family of carbon nanostructures (CNSs) includes a wide range of components as, among others, nanotubes, nanodiamonds, nanoonions, nanoribbons, graphene and its direct derivatives, graphene quantum dots, and nanodots. Despite they all present interesting characteristics, in the last years the most studied from many points of view are carbon nanotubes (CNTs), graphene oxide (GO), graphene quantum dots (GQDs), and carbon quantum dots (CQDs). CNTs consist of one or more concentric graphene sheets rolled in a cylindrical shape with diameters ranging from 0.4 nm up to 100 nm and are mainly monodimensional. Basically, graphene quantum dots (GQDs) combine the structure of graphene with the quantum confinement and edge effects of CDs and possess unique properties, which are important for the applications in medicine, electronic, photoluminescence, electrochemical and electrochemiluminescence. They mainly consist of 1 - 3 layers of graphene flakes with the diameter of less than 20 nm, which are considered to be almost zero-dimensional. The surface groups of the GQDs may vary due to the synthetic methodology, and photoluminescence peak of GQDs may shift depending on the surface functionalization. Vitrimers are another very interesting material and are covalent adaptable networks able to shuffle chemical bonds through exchange reactions at high temperature, allowing for material reprocessing.
This project will be devoted to the preparation of carbon nanostructures and to their specifically functionalization, and to bind to or embed them into vitrimers to impart conductive and/or optical properties. Functionalization could take place via boronic esters, β-hydroxy esters, or others, allowing for a wide variety of CNSs decorations. The presence of the CNSs, in particular of CNTs, into the vitrimers will act as repairing elements in case of polymer cracking. In fact, CNTs are able to increase the local temperature when irradiate by light and this phenomenon will induce the thermal repair of the vitrimers.