

Research project and activity plan

Luminescent silicon nanocrystals for energy technologies

The research project will be about the study of luminescent silicon nanocrystals as innovative materials with high performance in view of a sustainable development and innovation in the field of energy technologies, and the reduction of toxic emissions in the environment. In particular, it will be focused on the photochemical and photophysical characterization of new organic-inorganic hybrid materials consisting of silicon nanocrystals covalently functionalized with organic molecules. Silicon nanocrystals (SiNCs) possess several advantages with respect to more commonly employed quantum dots, which usually contain toxic and rare metals like lead, cadmium, indium, selenium: a) silicon is abundant, easily available and essentially non toxic; b) silicon can form covalent bonds with carbon, thereby offering the possibility of integrating inorganic and organic components in a robust structure; c) absorption and emission can be tuned across the entire visible spectrum from a single material, upon changing the nanocrystal dimension.

The synthetic procedure will be optimized in terms of cost of the starting materials as well as in terms of time. The synthesized SiNCs will be protected by alkyl chains to prevent oxidation and to facilitate dispersion in polymeric materials. The photophysical properties of these silicon nanocrystals will be studied in solution, as well as embedded in plastic films. Their chemical and photochemical stability will be tested under solar light irradiation.

The experimental work will include the use of steady-state and time-resolved absorption and emission spectroscopy, electrochemical (e.g., cyclic voltammetry) techniques will be employed to characterize organic molecules as well as their coupling to inorganic nanocrystals. The candidate will carry out a bibliographic search to keep updated with literature and to know recent developments in the field of quantum dots.