Research project

Photocatalysts and luminescent nanocrystals for solar energy conversion

The research project will be aimed at the design and realization of a system for the production of green hydrogen (solar hydrogen) using a photoelectrochemical cell that exploits solar radiation to provide the energy needed to carry out the water splitting process, with high efficiency, stability and sustainability. Within this project, the research activity of the candidate will be related to the study of photoactive molecules and to the design and synthesis of luminescent nanocrystals for the solar energy conversion. This research is funded by the research project entitled: "PRoduzione sostenibile di IDrogeno tramite sistemi fotoElettrochimici attivati dalla luce solare" (PRIDE).

The design and synthesis of the photoactive systems will take into account the following requisites: (i) absorption in the visible spectral range with large molar absorption coefficient; (ii) photostability under the investigated reaction conditions; (iii) proper redox properties for efficient photoinduced electron transfer processes occurring within the photocatalytic system.

The organic photoactive molecules that will be explored in the present project display thermally activated delayed fluorescence (TADF) and are based on electron accepting core appended with electron donating groups. These molecules display tunable redox properties via the modification of either the core or the acceptor units, absorption in the visible range, convenient handle to analyse the fate of the lowest singlet and triplet excited states in the photocatalytic cycle via prompt and delayed fluorescence.

The selected luminescent nanocrystals (e.g., $CuInS_2$ nanocrystals) will be synthesised and characterised from the structural, photophysical and electrochemical point of view. The synthetic procedure will be optimised in terms of photochemical properties and sustainability. The photophysical properties and the photocatalytic mechanism will be studied by steady-state and time-resolved techniques in the ultraviolet, visible and near infrared spectral region; the electrochemical characterisation will be mainly based on cyclic voltammetry with conventional and ultramicroelectrodes and it will be accompanied by spectroelectrochemical investigations.

The candidate will design the synthetic strategy, the photochemical experiments and will carry out a bibliographic search to keep updated with the recent developments in the field.