MATERIALS SCIENCE AND TECHNOLOGY

Production of Janus 2D material inks for energy conversion applications

Funded By	ERC - EUROPEAN RESEARCH COUNCIL - EXECUTIVE AGENCY Dipartimento DISAT
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Context of the research activity	DISAT - This research project aims at developing an innovative protocol for the production of 2D materials bearing different functionalities on the two opposite sides. The challenge is to implement the full process in the liquid phase and thus not resorting to solid phase transfer techniques, which is the current state-of-the-art. With this new method, Janus 2D material colloidal inks can be directly produced and used as they are, or for further solution processing of thin-films and devices.
Objectives	The PhD scholarship is in the framework of the European Research Council Starting Grant project titled "All-liquid phase JANUS BIdimensional materials for functional nano-architectures and assemblies" (acronym: JANUS BI), led by Prof. Teresa Gatti (Department of Applied Science and Technology - DISAT). The research activity concerns the development of a synthetic protocol taking place exclusively in the liquid phase to carry out the asymmetric functionalization of bidimensional materials. Such protocol will encompass the use of liquid-phase exfoliation techniques for layered materials and of various methods for the covalent and non-covalent functionalization of bidimensional materials. The species employed for such asymmetric functionalization will include other nanomaterials, small molecules or polymers having relevant properties of light-energy harvesting, charge conduction and/or catalytic activity towards the production of hydrogen from water or CO2 reduction. The research conducted must be comprehensive, starting from the preparation/characterization of the new hybrid nanomaterials, up to their test in devices for the conversion of solar energy on a laboratory scale. In particular, the research activities will regard: - the synthesis of the nanomaterials object of the research program in a chemical laboratory and their formulation into colloidal inks; - the physico-chemical optical and electrochemical characterization of the synthesized nanomaterials and of their inks; - the production of thin films from direct deposition of the nanomaterials-based colloidal inks through solution processing techniques;

	- the fabrication of optoelectronic devices on a laboratory scale; - the interfacing with the other members of the research group to give continuity and synergy between the various parts of the project; - the autonomous development of ideas and the opportune analysis of the experimental data; - the preparation of monthly reports on the experimental activity; - the drafting of scientific articles, reviews and patents on the basis of the results obtained, as well as the participation to national and international conferences and meetings in the field to present the results to the scientific and technical community; - the supervision of Bachelor and Master students carrying out thesis projects in the frame of the above described research

Skills and competencies for the development of the activity	Knowledge of colloidal chemistry, of low-dimensional materials and of their (opto)electronic properties. Knowledge of synthetic methods for low-dimensional materials and of physico-chemical characterization techniques (electron microscopy, x-ray diffraction, x-ray photoelectron spectroscopy, Raman spectroscopy, electrochemical methods). Knowledge of applications of low-dimensional materials in energy and optoelectronics, particularly in solar and photoelectrochemical cells.