SUSTAINABLE MATERIALS, PROCESSES AND SYSTEMS FOR ENERGY TRANSITION

IIT - Green perovskites for photo(electro)catalytic and photovoltaic applications

Funded By	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA [P.iva/CF:09198791007]
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Context of the research activity	Despite the impressive progress in technology development, there still remains a large scope for further advancement toward real-life applications. Indeed, all state-of-the-art efficiencies and stabilities of halide perovskite based devices have been achieved using non-sustainable and non-scalable approaches (i.e., use of toxic and harmful solvents and solution-processed spin coating).
Objectives	Solar energy is a promising and abundant clean energy source, and the technologies to harvest it and store it are rapidly developing. Among these, halide perovskites leaped to the forefront of photovoltaic research. These materials show an incredible set of physical properties, such as excellent light absorption capabilities, long charge-carrier diffusion lengths and easy band structure tailoring, which make them ideal for a large range of opto-electronic applications, including photo(electro)catalysis for the production of solar fuels. Challenges in fully exploiting halide perovskites for real life applications include the need of developing: 1. Green, solid-state synthetic techniques that can form materials without exogenous heat or hazardous solvent(s); 2. Deposition protocols for uniform coating of photoactive layers over large-area substrates; 3. Industrially compatible fabrication protocols to ascertain reproducible manufacturing; Good understanding of the precursor chemistry is needed to be able to control the synthesis of halide perovskite powders and films with different optoelectronic properties. An interplay between solvents, perovskite components, additives, and film formation dynamics needs to be resolved and optimized. The project will focus on delivering eco-designed, sustainably prepared, highly efficient, stable and scalable perovskite absorbers. Halide perovskites with different compositions and bandgaps will be investigated to

	ensure that the energetics match with the thermodynamic requirements of a specific catalytic process and the design of photovoltaic devices for both indoor and outdoor applications. The optimized materials will be then integrated in optoelectronic devices, namely photovoltaic solar cells and photo(electro)catalytic systems. All the perovskite materials developed will go through a continuous optical, structural, electronic characterization to help the synthetic process. Basic characterization (e.g. photoluminescence quantum yield, XRD, SEM, UV vis absorption, XPS, UPS) will be used to benchmark the materials' main properties and define a target application.

Skills and competencies for the development of the activity	Candidates should have a solid background in material science and engineering. Experience in synthesis of nanomaterials and thin films and optical, structural, electronic characterization are a plus. Practical attitude for the lab activities and problem solving skills, and high motivation to learn through advanced research are appreciated. The PhD candidate will work in contact with different research groups on a highly multidisciplinary project, hence they must demonstrate adaptability in different environments.