MATERIALS SCIENCE AND TECHNOLOGY

AMMIN/DISAT - Nanomaterials for Advanced Light Energy Management

Funded By	Dipartimento DISAT Politecnico di TORINO [P.iva/CF:00518460019]
Supervisor	GATTI TERESA - teresa.gatti@polito.it
Contact	RUBINO ANDREA - andrea.rubino@polito.it
Context of the research activity	The PhD position is focused on the study and development of innovative materials and devices for optoelectronics. This project lies at the intersection of materials science and device engineering, with a particular emphasis on energy-related applications ranging from next-generation photovoltaics to high-performance supercapacitors, up to multifunctional integrated systems capable of combining energy generation, storage, and intelligent management. Progetto PEROVSKAP - ID Progetto SOE_20240000032 - Bando PNRR Young Researchers - Linea Seal of Excellence – CUP E13C24002370006"; “Progetto Horizon Europe LEAF Grant agreement n. 101186701 CUP E13C24003140006”.
Objectives	The research will revolve around some of the most promising materials that have emerged in recent years. Hybrid and inorganic perovskites will be investigated for their outstanding optical and electronic properties, while two-dimensional semiconductors will open radically new opportunities for integration into thin and flexible devices. Doped metal oxides, thanks to their versatility and robustness, will provide fertile ground for realizing functional interfaces and complex architectures. The combination of these systems, together with doping strategies and nanostructural engineering, will be central to a study that aims not only to shed light on fundamental physical mechanisms but also to translate them into concrete, high-performance devices. A significant part of the project will focus on the preparation of materials. Several liquid-phase synthesis methodologies will be employed, such colloidal synthesis, sol–gel chemistry, liquid-phase exfoliation to obtain nanostructures with finely tuned composition and morphology and grow nanocrystals with targeted optical and electrical features. Solution processing techniques will be explored, as spin-coating, dip-coating, spray-coating, to optimize the formation of thin, uniform films with high quality. Following synthesis, the candidate will engage in comprehensive characterization in order to fully understand the fundamental properties of the

	studied systems. Morphological and structural features will be examined by advanced electron microscopies (SEM and TEM) and X-ray diffraction, which are essential to correlate nano- and microstructure with device performance. On the spectroscopic side, steady-state and time-resolved photoluminescence, Raman spectroscopy, and UV–vis/infrared absorption techniques will be employed to probe charge-carrier dynamics and light –matter interactions. Electrochemical analyses will complement this picture through cyclic voltammetry, capacitance measurements, and electrochemical impedance spectroscopy, enabling the evaluation of performance in supercapacitors and other integrated energy applications. The project is embedded in a network of national and international collaborations that will ensure the PhD student a truly global research experience. Through participation in large-scale projects (leaf.polito.it), the candidate will have the opportunity to spend research periods abroad in partner universities and leading research centers, gaining specialized expertise and engaging with complementary approaches. These mobility opportunities will not only enrich the scientific background but also foster the creation of a strong professional network at both European and global levels.

Skills and competencies for the development of the activity	The ideal candidate holds a master's degree in physics, chemistry, materials science, materials engineering, electronics, or related fields, with a solid background in materials chemistry. Fluency in English, both written and spoken, is required, together with a genuine interest in interdisciplinary research and teamwork. Scientific curiosity, self-motivation, and a drive to contribute to sustainable and innovative technologies will be key to thriving in this PhD experience.