Advanced electron microscopy of hybrid perovskite materials for energy applications

Tutor: Giorgio Divitini

About the Project

The green revolution will require significant breakthroughs in both energy production and end-use efficiency. In the last 10 years hybrid perovskites have emerged as a very promising class of materials with excellent optical and electronic properties, and have been successfully been employed in prototype solar cells for photovoltaic power generation and other optical systems, such as light emitting diodes (LEDs). The range of applications is very broad and include, for example, multi-layer solar cells improving power conversion efficiency over a single silicon junction (still the most established technology), semi-transparent solar cells for smart windows, and flexible solar cells. Similarly, high-brightness LEDs have been demonstrated and would enable significant energy savings in lighting. Some peculiar properties of hybrid perovskites, such as the flexibility in chemical composition and tolerance to defects, suggest that the scientific community has only started to scratch the surface on potential applications for this class of materials.

As new compounds are designed and as devices are tested in realistic settings, there is an increasing need to understand the properties and dynamic processes of hybrid perovskites at the nanoscale. Electron microscopy is a prime candidate for this analysis, due to the ability to access information on morphology, chemical composition and crystallography at the nanoscale. This is generally a very challenging process, as hybrid perovskites are known to get damaged easily by the electron beam. Equipment, acquisition protocols and data analysis procedures all need to be optimised to unravel nanoscale structure and processes in these materials, making this project very rewarding.

This PhD position, which will be based in a group centred around electron microscopy, will include extensive use of the ThermoFisher Spectra 300 Transmission Electron Microscope just installed at the Italian Institute of Technology – a state-of-the-art instrument, among the top electron microscopes in the world -, which features high-efficiency detectors and class-leading electron optical capabilities. It will include experimental microscopy work, experiment design and the use of advanced algorithms for data analysis (predominantly python-based). The project is part of a strong existing collaboration between the Electron Spectroscopy and Nanoscopy research line at IIT and international partners (the University of Cambridge, the University of Rome Tor Vergata).

Requirements: The ideal candidate must have a Master's Degree or equivalent in one of the following areas: Material Science, Physics, Chemistry, or Chemical Engineering. Experience with electron microscopy and familiarity with python would be valuable but are not required.

For further details concerning the project, please contact: giorgio.divitini@iit.it