Navigating Stress: Insights from Halide-Perovskites on Diverse Stress Responses

18 Dicembre 2023, aula B, DiFC, edificio 17 viale delle Scienze

Loreta A. Muscarella[1,*]

1. Department of Physics and Astronomy, Vrije Universiteit (VU) Amsterdam, The Netherlands

*loretaangela.muscarella@gmail.com

Halide perovskites are a promising candidate for next generation energy-harvesting technologies owing to their excellent optoelectronic properties and low-cost solution processability. A striking difference between halide perovskites and conventional semiconductors (e.g., silicon) is the dual ionic-covalent bond nature within the anionic inorganic framework. This bond nature results in a mechanically soft and dynamically disordered lattice whose alteration affects the optoelectronic properties and the stability of these solids. Thus, metal-halide perovskites are particularly sensitive to variations in composition, fabrication and external stimuli that can induce strain in the material. The high magnitude of strain in halide perovskites is remarkable as they are one of the most fragile semiconductors, yet their resilience to adapt to stress is their most fascinating property. In the present talk, I will start by providing a short introduction to halide perovskites and to the fundamentals of strain on different length scales. I will show how electron-backscattered diffraction (EBSD) in combination with other spatially-resolved techniques can serve as a tool to correlate locally the structural and optical properties at the nanoscale. I will continue by showing a unique pressure-dependent transient absorption spectroscopy setup used to study the phase segregation process in mixed-halide perovskites and demonstrate how compositional engineering strategies applied during the fabrication process can result in similar effects as applying external pressure.

[1] Reversible Pressure-Dependent Mechanochromism of Dion-Jacobson and Ruddlesden-Popper Layered Hybrid Perovskites, Loreta A. Muscarella et al., Adv. Mater. 2022, 34, 2108720. https://doi.org/10.1002/adma.202108720

[2] Lattice Compression Increases the Activation Barrier for Phase Segregation in Mixed-Halide Perovskites, Loreta A. Muscarella et al., ACS Energy Letters 2020 5, 10, 3152-3158, https://doi.org/10.1021/acsenergylett.0c01474

[3] The influence of strain on phase stability in mixed-halide perovskites, Loreta A. Muscarella, Bruno Ehrler, Joule 2022, 6, 2016-2031 https://doi.org/10.1016/j.joule.2022.07.005