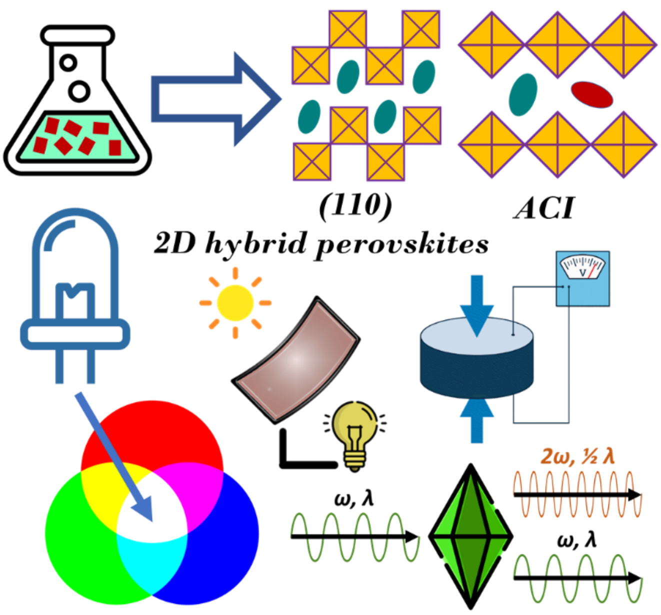
In the vast realm of materials science, a certain class of compounds has captured the attention of researchers and industry – the hybrid organic-inorganic perovskites (HOIPs). These fascinating materials, known for their exceptional properties and potential applications, have opened up new horizons in fields ranging from photovoltaics to optoelectronics. Solar cells based on HOIPs have emerged as a game-changing technology in the field of photovoltaics, demonstrating remarkable power conversion efficiencies (on the level of traditional silicon-based ones), but produced as thin, semi-transparent and flexible foils. HOIPs also possess excellent charge transport properties and can be easily processed from solution, paving the way for the production of much cheaper and more efficient devices than the current technology. Apart from photovoltaics, HOIPs reveal the potential in a wide range of optoelectronic devices, including LEDs, lasers and photodetectors, exhibiting high photoluminescence quantum yields (PLQY) and colour tuneability, making them promising candidates for next-generation lighting and display technologies.



An emerging issue of instability of perovskites, being the barrier to their commercialization, has sparked scientific curiosity in the development of perovskite-derived materials, such as layered (2D) HOIPs, where the perovskite layers (like ultra-thin sheets, only a few atoms thick) are separated by organic spacers. Optoelectronic devices based on the 2D HOIPs exhibit enhanced durability, superior quantum yields and arguably endless ways of chemical modification, making their applicational spectrum even wider than for the classic (3D) perovskites. In terms of modification, one may exchange both organic and/or inorganic constituents, leading to a plethora of different combinations and possibilities of tuneability of the optoelectronic properties.

In the wide variety of 2D hybrid perovskites, we focus on two specific subclasses – namely (110)- and ACI-type. Both families are relatively new and remain in almost uncharted territory. The (110)-type perovskites reveal the potential for white-light-emitting devices, offering the ability to replicate natural daylight, which is essential for enhancing visibility, productivity, and overall well-being. The ACI-type ones bring the 2D perovskites closer to their 3D counterparts in terms of photovoltaic performance.

In this context, we aim to synthesise novel (110)- and ACI-type perovskites, based on lead halides (Br, Cl, I) with small, mostly polar organic cations. We will characterise their structural alignment, phase transitions, as well as optical and electrical properties in a broad temperature spectrum. The planned studies will bring us information on the relationships between the crystal structure and physiochemical properties. This is a crucial correlation for a better understanding of these materials' behaviour, paving the paths for designing new hybrid perovskites with improved physicochemical features, especially in the light-emitting and photovoltaic scope.