Tuning the properties of 2D halide perovskites through the organic component

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Two-dimensional halide perovskites are analogues of 3D perovskites that are of strong interest for photovoltaics. These 2D-analogues have properties that are markedly different than those of the corresponding 3D perovskites, for instance a considerably larger band gap and much stronger interactions between electrons and hole in the inorganic part of the material, i.e. a much large exciton binding energy. We have shown in a recent study that also the exciton binding energy can be tuned over a large range by varying this thickness. Until recently, most of the large organic cations used in 2D or quasi-2D perovskite materials only act as a spacer, defining the dimensionality of the system. Their HOMO-LUMO gap is generally very large and the electronic properties of the resulting materials are fully determined by the properties of the inorganic layers.

In this work, we aim to introduce additional functionality in the organic part. This can be done using two approaches: an indirect one in which the organic component induces structural changes that in turn lead to changes in the electronic properties, and a direct one where the electronic states of the organic part of the material are directly involved. In this lecture I will discuss examples of both approaches. The first is the introduction of functional organic molecules in between the octahedral perovskite layers to induce charge separation. The second example involves the relation between the nature/structure of the organic component and the structural dynamics.