NANOARCHITECTONIC PHOTOELECTRODES BUILT-UP FROM OCTAHEDRAL METAL ATOM CLUSTER-BASED BUILDING BLOCKS FOR SOLAR CELL APPLICATIONS

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Ambipolar materials are a class of compounds that can intrinsically transport and transfer simultaneously both charge carriers, holes and electrons in a comparable way.[1] Unlike conventional unipolar semiconductors in which a type of charge carrier is predominant, ambipolar materials can display p-type and n-type characteristics within a single device, which makes them attractive materials for many different application fields such as sunlight conversion. [2,3] Only few materials such as semiconducting polymers, carbon nanotubes, 2D materials or organic-inorganic hybrid perovskites exhibit ambipolar behaviors.[1,3] Their intriguing intrinsic physical properties result from their specific electronic structures which are not only related to the chemical compositions but also to morphology and size effects.[1,3]

The authors recently investigated the ambipolar character of Mo_6 clusters compounds. Transition metal cluster (MC)-based halides are nano-objects that have a tri-dimensional size restriction giving them fascinating optical and electronic properties such as molecule-like energy gaps, strong absorption in the visible and/or NIR spectral regions, deep red luminescence or high (photo)catalytic effectiveness.[4-8] Outstanding ambipolar properties of MC compounds were highlighted through a range of photoelectrochemical characterizations and led to the design, as a demonstrator, of an all solid solar cell integrating an MC-based light-harvester.[4] Thus, this presentation will be firstly focused on the evidence of the ambipolar character of Mo_6 cluster iodides, from its origin to its interest for solar energy conversion, before to generalize these new outstanding properties to the octahedral cluster family through the investigation of Re_6 and mixed $(Re,Mo)_6$ sulfides and selenides. To do so, we will rely on a set of complementary characterization techniques: optical (UV-Vis), spectroscopic (XPS) and electrochemical (steady-state and transient (photo)electrochemistry) techniques.

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