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]

Recently, the authors have completed this family of materials by a new series of compounds, namely the transition metal cluster (MC) compounds based on Mo_6, Re_6, and mixed $(Mo,Re)_6$ clusters.[4] $[\{M_6(Q,X)^i_8\}L^a_6]$ (M = Mo or Re, Q = S ou Se, X = I and L = Cl, I or H_2O) cluster building blocks have a nanosize scale 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.[4-7] They are particularly well suited for nanoarchitectonics[8,9] whose concept is based on the assembly of nanoscale units to reach new original physical properties. Thus, this presentation will be focused on the design by electrophoretic deposition process of such MC-based nanoarchitectonic layers that led to the development of new ambipolar photoelectrodes. Beyond the deposition route, the origin and the engineering of the MC-based layer ambipolar properties of will be discussed before to consider their interest for the solar energy conversion. 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.

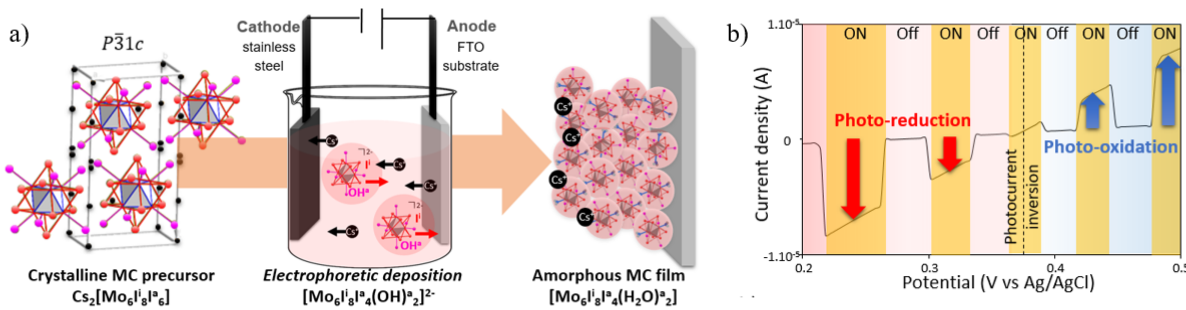

Figure 1 – Example of a) preparation by EPD and b) evidence of ambipolar properties by current−potential measurements under chopped illumination of amorphous MC films obtained from MC crystalline powder.

[1] Y. Ren **et al.**, *RSC* 2021, 1-13.
[2] S. Z. Bisri **et al**, *Adv. Mater.* 2014, 26, 1176-1199.
[3] G. Giorgi **et al.**, *J. Mater. Chem. A* 2015, 3, 8981-8991.
[4] A. Renaud **et al.**, *ACS Appl. Mater. Interfaces* 2022, 14, 1347-1354.
[5] A. Renaud **et al.**, *Electrochimica Acta* 2019, 317, 737-745.
[6] Y. Zhao ***et al.**, Adv. Energy Mater* 2013*,* 3, 1143-1148.
[7] M. Feliz ***et al.**, ChemSusChem* 2016, 9, 1963-1971.
[8] N. T. K. Nguyen ***et al.**,* Sci. Technol. Adv. Mate. 2022, just accepted, doi: 10.1080/14686996.2022.2119101.
[9] K. Ariga, *Nanoscale Horiz.* 2021, 6, 364−378,