New surface-supported metal-organic framework thin films (SURMOFs) for molecules capturing and photoconversion

Protecting the human health by ensuring the quality of drinking water, together with energy efficiency and energy saving obligations, are the main pillars of European Union politics and also fits *Sustainable Development Goals* (SDGs 6 and 7). In view of this, new materials and technologies - useful in water treatment and sustainable energy production - are still in demand. In recent years, metal organic frameworks (MOFs) have been intensively explored for various applications, including clean energy production, gas storage and pollutants removal (*via* sorption and degradation). MOFs allow to combine the properties of both organic and inorganic porous materials due to the presence of metal ions connected with organic linkers. Moreover, recently surface supported metal-organic frameworks (SURMOFs) are found more attractive for some applications, including optical coatings, catalysis, gas separation or as sensors. SURMOFs have a number of benefits over bulk MOFs including: (1) homogeneous, smooth morphologies with low surface roughness; (2) tuneable thickness by optimizing cycles for deposition; (3) easy to scale-up at industrial level *via* spray coating method; (4) precisely lined-up films and the ability to manipulate crystal alignment; (5) a decreased defect density compared to the bulk material. Additionally, surface-supported MOF thin films exhibit a number of advantages with regard of photocatalytic reactions such as *(i)* enhancement of the local concentration of reagent (eg. CO_2), (*ii*) elimination of catalyst deactivation due to particle aggregation, (iii) easier separation of the catalysts from the reaction solution, and (iv) promotion of light-induced charge separation.

The proposed CleverSURMOFs project consists of nine tasks aligned with its goals. The project will begin with synthesizing MOF thin films on various functionalized substrates *via* four different methods. Sandwich-type SURMOFs will be formed by varying metal ions and linkers during synthesis. Substrate type and functionalization are expected to influence SURMOF thickness and properties. The films will be thoroughly characterized using techniques like SEM/TEM, XRD, AFM, FTIR, XPS, UV-Vis, and tested for gas/water sorption and photocatalytic activity to understand reaction pathways.

The breakthrough proposed in the project will be related with development of novel SURMOFs on various matrix for selective capture of gases (H_2, CO_2, CH_4) and water pollutants (e.g., trihalomethanes, haloacetic acids). These thin-film MOFs will offer enhanced surface functionality, selective binding, high sorption capacity, and reusability. Unlike bulk MOFs, SURMOFs overcome mass transport limitations, enabling more efficient molecule capture in application-ready forms. Creation of SURMOFs on carbon- and semiconductor-based substrates provides materials for efficient H_2 evolution and CO_2 photoconversion with boost charge transport and catalytic activity. Moreover, development of sandwich-like structures with at least two different MOF layers on substrates enable combining sorption and photocatalytic functions or targeting different photoreactions (HER, OER, CO_2RR). This design enables efficient, ready-to-use photocatalytic surfaces while reducing MOF material usage.

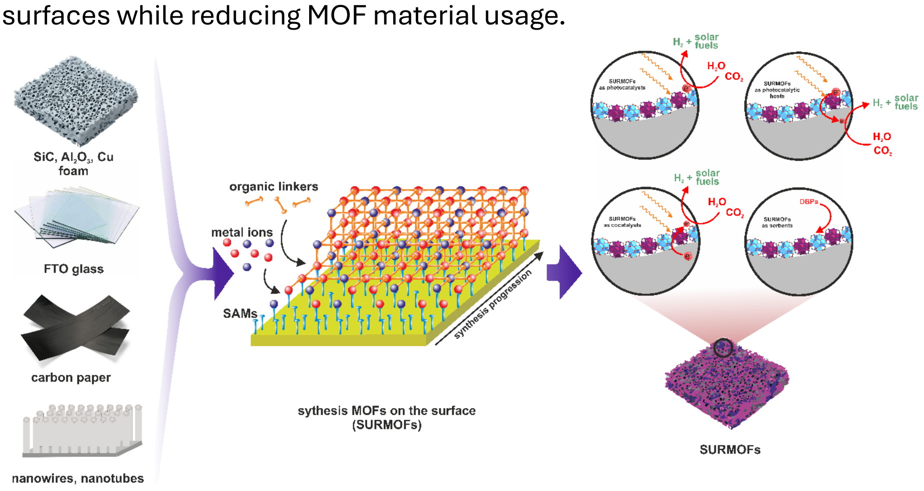

Figure 1. General idea of the proposed project