The increasing demand for sustainable energy solutions presents one of the greatest challenges of our time. Photo(electro)catalytic water splitting, which involves the efficient production of hydrogen from water using sunlight, has emerged as a promising strategy to meet global energy needs. However, current methods face significant challenges, particularly in the oxygen evolution reaction (OER), a critical step where oxygen is formed at the anode. This process is hindered by slow kinetics and the unwanted formation of hydrogen peroxide, which poisons the catalysts and reduces efficiency.
The CHIRALMAT project aims to tackle these challenges by leveraging the unique properties of chiral materials. Chiral materials, which have handedness (left or right), can act as spin filters due to the chiral-induced spin selectivity (CISS) effect. This effect allows these materials to favor the transfer of electrons with a specific spin orientation, potentially enhancing the efficiency of the OER and reducing the formation of undesirable byproducts.

The CHIRALMAT project addresses key obstacles in water splitting, such as high overpotential and low current densities, by employing chiral materials that utilize the CISS effect. This approach promises to enhance the efficiency and selectivity of water splitting processes, making them more practical for real-world applications.

The CISS effect, discovered in 1999, has shown that chirality can influence electron spin orientation, significantly impacting the efficiency of various processes, including water splitting. Despite these advancements, detailed studies on the application of the CISS effect in water splitting are still limited. CHIRALMAT aims to fill this gap by exploring the use of novel chiral materials and comparing different approaches, such as functionalization versus intrinsic chirality, to determine the most effective methods for enhancing water splitting efficiency.

The project aims to demonstrate that chiral nanomaterials (photoabsorbers, catalysts, electrolyte) can significantly improve the efficiency of photo(electro)catalytic water splitting by reducing overpotentials and suppressing undesirable byproducts. The findings will provide insights into the mechanisms of the CISS effect and pave the way for more efficient and sustainable hydrogen production technologies.

Successful implementation of this project will contribute to the advancement of renewable energy solutions, supporting global efforts towards a sustainable energy future.