The global energy supply and related environmental issues are among the biggest technological challenges being confronted by chemists and technologists in the 21st century. The conversion of solar energy into fuels is considered to be a viable solution to global energy problems. One of the cleanest fuels for energy production that comprises an easily accessible element is H_2, which can be produced via water splitting under solar light irradiation. The important problem for solar fuels generation is to produce high-efficiency, low cost, and robust catalytic systems. The photo-to-energy conversion efficiency is low owing to the poor electron transport between the dye and the catalyst. Innovative two dimensional 2D materials with unique layered structures are expected to further enhance photocatalytic activity by increasing the efficiency of electron transfer. The graphene revolution, the most famous 2D-layered material led to an entirely new domain of research of similar structures. Beyond graphene, there is also a wide spectrum of other 2D layered materials. Among them transition-metal carbides and carbonitrides (MXenes), a new family of 2D materials, were first reported in 2011 and since then are gaining attention as a suitable alternative for promoting photocatalytic performance. **The main objective of this project is to fabricate novel hybrids based on Ti_3C_2Tx MXenes and to apply them in photocatalytic hydrogen production. By functionalizing various dye molecules and catalysts to MXene sheets, we intend to obtain multicomponent nanohybrids with the needed charge-separation properties which will enhance their photocatalytic activity. In addition it is planned to establish the link between morphological properties of the MXene material (surface area, lateral size, thickness, oxidation degree) and photocatalytic activity.**

From a point of view towards future practical applications, light-harvesting photosensitizers and catalysts should rely on earth-abundant elements. Thus, in this project we intend to investigate photocatalytic hydrogen generation in multicomponent hybrid nanomaterials derived from earth-abundant materials.

Studies that we are going to undertake can make an interesting contribution to the fundamental research on 2D-layered materials role in photocatalyticH_2 generation. We strongly believe that a complete mechanistic understanding will pave the way to efficient and stable designs of composites materials for photocatalytic processes. Furthermore these studies will facilitate the identification of crucial factors that limit the efficiency of the overall system and provide promising results for future applications. Thus our concept will further advance the state-of-the-art in the field. With this as background, the development of novel photocatalytic materials based on MXene materials, if successful, will be very useful especially in the context of the possible number of practical applications.