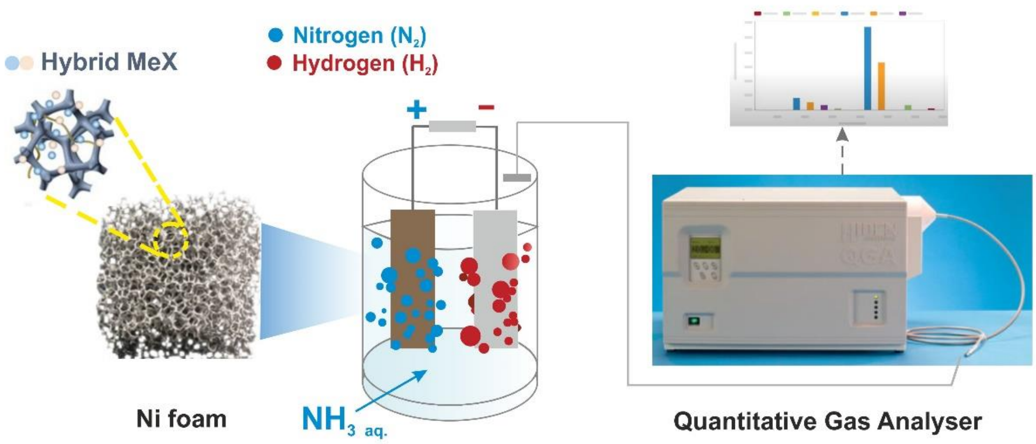
Novel non-noble metal-abundant based catalysts for ammonia electrooxidation

Typical systems for water electrolysis produce hydrogen on cathode and oxygen on anode. The cathodic hydrogen evolution process has been well developed, whereas the oxygen evolution reaction poses many practical obstacles, mainly resulting from high voltage (low energy efficiency) and the hazard of H_2-O_2 mixture explosion. In this regard, replacing water oxidation with ammonia oxidation will result in more safe solution due to nitrogen evolution on anode instead of oxygen. Moreover, the ammonia oxidation reaction should consume less electric energy than water oxidation. However, the development of ammonia electrooxidation technology is hindered by the lack of efficient, cheap, and durable catalysts. The state-of-the-art catalysts for this process are still the traditional noble metals, such as Pt, Ir, and Ru, with prohibitive cost, low natural abundance, and proneness to poisoning, which are undesirable for sustainable energy-related applications in the future. Therefore, our studies are to be focused on the development of novel hybrid catalysts for ammonia electrooxidation starting from oxides, chalcogenides and phosphides of Ni, Fe, Co, Mo and Cu. The important assets of these substances include a low toxicity, low costs, earth abundance and also structural properties such as a suitable electronic band structure. We are going to take advantage of our own experience and recent innovation in the field of synthetic nanotechnology to design and synthesis nanostructured hybrid catalysts with enhanced activity, tunable selectivity, and superior stability.

The proposed project consists of five main tasks related to preparation of the nanosized catalytic materials containing single metal, and based on the initial electrochemical assessment selection of the compounds with high activity and stability for further characterization and for hybrid electrocatalysts formation. The composition and surface properties of the catalysts will be examined by various analytical methods to correlate them with electrochemical properties.

The most significant expected outcome of the project will be stable electrocatalysts, which guarantee low energy cost of the electrochemical ammonia oxidation reaction. The fundamental understanding generated through the project will eventually force the development of other research areas such as ammonia fuel cells, in situ hydrogen generation, chemical sensing, and nitrate reduction for wastewater treatment.

Due to the interdisciplinary character of the proposed research, the involved team members would have experience in electrochemistry and material engineering. In addition, the research will be also performed in Paul Scherrer Institute (Switzerland), having longstanding experience in electrocatalysis and interface analysis.



General idea of the proposed project