The sun offers the potential for harvesting enormous amounts of energy, although its present-day contribution to the energy mix is a miniscule 1-2% [1]. The amount of solar power striking the earth’s surface at any one instant is equivalent to 130 million 500 MW power plants [2], nearly 10^4 times greater than our present day power needs. The ability to capture even a small percentage of this huge abundantly available resource would render unnecessary the current reliance on CO₂ emitting fuel sources.

Photocatalytic or electrochemical water splitting, referred to very often as artificial photosynthesis, is a middle-to-long term solution with tremendous promise. In analogy with nature’s design, water is used as a feedstock of photons and electrons that are used to generate hydrogen fuel, a process which is driven by the energy contained in the solar photons. The energy-rich gaseous fuel product can participate directly in a hydrogen economy, or can be used to generate syn-gas, methane or ammonia, which is possible with present-day industrial scale technology. The strategy of generating a fuel, and not electricity, from sunlight alleviates the problems associated with electricity storage. This project is designed to address major challenges that have thus far hindered the industrialization of artificial photosynthesis. It aims to find and improve cheap and efficient photocathode and photoanode materials for photoelectrochemical applications and to ensure long term operation with the implementation of corrosion resistant protective coatings.

Synthesis routes of LTON semiconductor powders and their performance enhancement by adding co-catalysts and protective layers

**Photoanode**

**Synthesis and Morphology tuning of LaTiO\(_2\)N**

Soft chemistry and anionic substitution via thermal ammonolysis: A solid – gas reaction with NH\(_3\) at T = 950 °C which allows morphology tuning.

La\(_2\)Ti\(_2\)O\(_7\) + 2 NH\(_3\) \rightarrow 2 LaTiO\(_2\)N + 3 H\(_2\)O

**Performance enhancement by adding co-catalysts and protective layers**

CoO\(_x\) nanoparticles as co-catalysts

Adding protective layers

**Photocathode**

**Solution transformation of Cu\(_2\)O into CuInS\(_2\)**

Cu\(_2\)O Band gap 2 eV

CuInS\(_2\) Band gap 1.5 eV

Photoelectrode: Electrolyte: 0.5 M H\(_2\)SO\(_4\)

Passivating CuIn\(_{1+}\)Ga\(_{\theta}\)Se\(_2\) towards efficient and durable water reduction

**INTERROGATION**

The photoanode and the photocathode will be combined, together achieving the required photovoltage to enable unbiased overall water splitting. This new device will enable unassisted solar water splitting.

**Possible device architectures for Tandem cells**

Synthesis routes of LTON semiconductor powders and their shape, size, band gap, and BET surface area

**RESULTS after 18 months**

Photocathode: Solution synthesis of CulnS\(_2\) and surface passivation of Culn\(_{1+}\)Ga\(_{\theta}\)Se\(_2\) towards efficient water reduction.

**REFERENCES**