Electrolytes for Ammonia Production in the SuN2rise ERC-StG Project

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The preservation of our planet is the most urgent issue in the world and the scientific community is pushing a lot of researchers to work on technologies for the storage/conversion of CO2 into chemicals. However, it is easier not to produce CO2 than setting-up plants to treat it.
In this framework, the ERC-StG project SuN2rise proposes an alternative breakthrough based on a versatile solar-driven strategy leading to redesign industrial processes. Facing the Haber-Bosch process for ammonia production (one of the most impactful chemical processes today), we propose the electrochemical fixation of dinitrogen into ammonia, by simply using air, water and ambient conditions. The scientific aim is that of demonstrating an integrated device where a photovoltaic (PV) unit will power a regenerative electrocatalytic cell converting dinitrogen to ammonia (E-NRR). A newly proposed Li-mediated approach under mild conditions, derived from an interdisciplinary contamination between electrocatalysis and Li-batteries, will be the key towards N2 conversion, bypassing both the competitive hydrogen reduction reaction and the complete irreproducibility of recent E-NRR approaches attributed to N-contaminations or degradation of N-based catalysts.
Electrolytes play a crucial role in the electrochemical production of ammonia via nitrogen reduction, directly influencing efficiency, selectivity, and stability of the process [1-3]. They facilitate ion transport, optimize reaction kinetics, and help stabilize active sites on the electrocatalyst. The choice of electrolyte affects the proton availability, which is essential for the reduction pathway, while also preventing competing hydrogen evolution. Advanced ionic liquids, deep eutectic solvents, and tailored aqueous solutions are being explored to enhance nitrogen solubility and improve reaction yields. Developing high-performance electrolytes is key to making electrochemical ammonia synthesis a viable and sustainable alternative to the Haber-Bosch process.
The team will further move beyond the state-of-the-art by fabricating transparent devices, that can be integrated in greenhouses, allowing the production of ammonia and ammonium fertilizers directly in farms, bypassing the known issues related to the massive infrastructure of ammonia plants and difficulties in reaching remote communities. The proposed approach will significantly impact also the field of liquid fuels, being ammonia safer and with higher energy density than hydrogen. Achieving these goals will require multidisciplinary expertise in the field of chemical, material, process and device engineering

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References

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