Syngas production through an intensified process: Coupling of CO_2 capture and electrochemical conversion.

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Anthropogenic activities have impacted the planet's carbon cycle through large amounts of greenhouse gases (GHGs) emissions, shifting the equilibrium of human history since the industrial revolution. CO_2 is the key contributor to global climate change in the atmosphere. Electrochemical CO_2 reduction can remove it from the atmosphere and provide valuable chemicals and fuels, representing an opportunity to support a low-carbon economy.[1] In this regard, an extraordinary effort has been made to discover new efficient and sustainable catalysts at the laboratory level over recent years. High-performance electrocatalysts in aqueous electrolytes often rely on noble metals, which may hinder their industrial applications. Herein, we successfully synthesized core-shell Cu_2O/SnO_2 nanoparticles functionalized with a silane group, using a simple and versatile methodology based on a three-step scalable synthesis method involving wet precipitation followed by salinization and, finally, a rhenium-based complex has been assembled by electro-polymerization. The carbon paper-supported Cu_2O/SnO_2-Re electrocatalyst was characterized at 10 cm^2 scale, demonstrating a steady-state production of syngas at -20 $mA \cdot cm^{-2}$ for more than 3 hours and achieving a CO:H_2 ratio higher than 3. To translate those developments from the laboratory level to a higher TRL towards the practical application for CO_2 capture and utilization[2], an additional chamber was added to the system for the continuous CO_2 capture and electrochemical conversion, while increasing the electrode area from 10 cm^2 to 100 cm^2. Captured CO_2 co-electrolysis to syngas (H_2:CO ratio of 5) in one step was demonstrated with a high CO_2 conversion at a current up to -2 A, indicating the scale-up potential of this intensified system. Besides, to further enhance the performance, ionic liquids (ILs), which have unique properties, have been proposed to perform CO_2 capture and to boost CO_2-derived products. In this work, for the first time, Cu_2O/SnO_2-Re-based electrode has been used within a continuous flow cell and in the presence of ILs-based solutions. In particular, we have observed different stability issues, such as the blackening of typical carbon-based gas diffusion layers (GDLs) and the degradation/colour changes of ILs-electrolyte. Field Emission Scanning Electron Microscopy (FESEM) and Electrochemical Impedance Spectroscopy (EIS) techniques have been employed to carry out the physicochemical characterization of the electrodes and to assess the electrochemical interfaces within the system, respectively. The observed findings definitely offer openings for large-scale deployment of carbon capture and CO_2 reduction technologies.

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References

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