A Carbon Neutral Approach to Long Duration Energy Storage through Manipulated Interfaces for Enhanced Carbon Dioxide Electrolysis

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Abstract: Large-scale energy storage is a key enabling technology for the wide spread adoption of renewable generation on the power grid. The intermittent nature of renewable generation leads to instability in the grid and large-scale energy storage has been shown to be an effective solution for multiple grid applications with different power and duration requirements. Although several storage technologies are capable of providing storage on the order of minutes to hours, very few can provide long duration storage (days to weeks) with the exception of pumped hydro. The lack of long duration storage will require fossil fuel based generation to provide power during the absence of renewable resources that extend beyond a day. One promising technology for long duration energy storage is P2X (power to fuels or chemical) which is based on the electrochemical conversion of reactants through electrolysis. The utilization of carbon dioxide from industrial waste streams offers both a reactant source for chemical based storage and can allow significant reductions in global carbon dioxide emissions. Solid oxide electrolysis is a highly efficient, high temperature approach that reduces polarization losses and best utilizes process heat; however, the technology is relatively unrefined currently for carbon dioxide electrolysis. In most electrochemical systems, the interfaces between active components are usually of great importance in determining the performance and lifetime of any energy materials application. Here we report a generic approach of interface engineering to achieve active interfaces at nanoscale by a synergistic control of materials functions and interface architectures. The composite cathodes with in situ grown interfaces demonstrate significantly enhanced carbon dioxide electrolysis and improved durability. With these results we also investigate a multi-energy systems scenario for chemical production as energy storage that can lead to increased exergy when compared to singular processes. A first-cut economic model will also be presented to demonstrate the economic viability of the overall process.

Key words: carbon dioxide, electrolysis, interface engineering, energy storage

References

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