PRODUCTION OF GREEN CHEMICALS AND FUELS FROM CO_2/H_2O CO-ELECTROLYSIS IN PROTONIC CERAMIC CELL REACTORS

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ABSTRACT

Co-electrolysis of H_2O and CO_2 in protonic ceramic cell reactors (PCMRs) is considered a promising approach to convert CO_2 into value-added products, but also a way to in-situ store green hydrogen in the form of chemicals or fuels from intermediate temperature (400-600 ^oC) H_2O electrolysis.[1] In such PCMRs, steam splits (oxygen evolution reaction-OER) over the anodic electrode (positrode) while the protons created are subsequently transported through the ceramic electrolyte to the cathodic electrode (negatrode) where they react with CO_2 towards chemicals/fuels. This system exhibits significant challenges regarding the choice of the electrocatalysts' components at both sides of the ceramic membrane. For instance, the highly oxidizing environment of the anodic steam electrolysis rules out the state-of-art Ni-based ceramometallic (cermet) electrodes, whereas the CO_2 electrocatalyst environment should be appropriately tuned to achieve high selectivities to the desired products.[2] Herein, we have developed and evaluated the performance of promising mixed ionic-(protons, oxygen ions) electronic conducting oxides (perovskites and misfit layered ones) for H_2O electrolysis to deliver high protonic fluxes at intermediate temperatures. Several PCCR systems allow > 75% faradaic efficiency with a significant number of protons reacted with CO_2 towards syngas and CH_4, showing a strong dependence on the operation temperature and current density.

KEYWORDS: Hydrogen production, chemical energy storage, CO_2 valorization, electrocatalysis

REFERENCES

[1] L. Lei, J. Zhang, Z. Yuan, J. Liu, M. Ni, and F. Chen, "Progress Report on Proton Conducting Solid Oxide Electrolysis Cells," Advanced Functional Materials, vol. 29, no. 37, 2019

[2] N. Shi et al., "Controllable CO2conversion in high performance proton conducting solid oxide electrolysis cells and the possible mechanisms," Journal of Materials Chemistry A, vol. 7, no. 9, pp. 4855-4864, 2019

ACKNOWLEDGEMENTS

This work is part of the ECOLEFINS project (10.3030/101099717) which is funded by the European Innovation Council (EIC) in the context of HORIZON-EIC-2022-PATHFINDEROPEN-01 program.