Perovskite-Based Solar Cells for Hydrogen Production: Photovoltaic-Assisted Water Splitting and Photoelectrochemical Monolithic Devices

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INTRODUCTION

Among the green hydrogen production methods, photovoltaic-powered water splitting is promising for directly splitting water into hydrogen and oxygen without intermediate power supply systems, and hybrid organic-inorganic halide perovskite materials have emerged as ideal candidates. Organic perovskites have also recently been investigated for photoelectrochemical generation at low cost and thin films on polymer devices. The integration of perovskite photoanodes with catalysts in monolithic devices seamlessly combines the roles of solar cells and anode-cathode electrodes, reducing costs and enhancing efficiency by minimizing energy losses. However, challenges persist, particularly regarding the long-term stability of devices[1].

EXPERIMENTAL

Perovskite-based solar cells were used to develop an array optimized for photovoltaic-powered photoelectrodes, which could help reduce the overpotential for water splitting. Subsequently, the focus shifted to the integration of perovskites with conventional/innovative catalysts to realize monolithic photoelectrodes.

RESULTS AND DISCUSSION

Different configurations were optically and electrically characterized in the dark and under illumination to evaluate the photovoltaic parameters required for cell monitoring. Current-voltage characteristics were measured by linear sweep techniques across different photoanodes and perovskite solar cells, complemented by electrochemical impedance spectroscopy, equivalent circuit modeling, and Nyquist plot analysis under dark and illuminated conditions. Morphological and cross-sectional analyses of the PV cells were also performed. Preliminary tests demonstrated the functionality of the proposed configurations (Fig. 1) and confirmed their potential for integration into photovoltaic-powered photoelectrochemical systems.

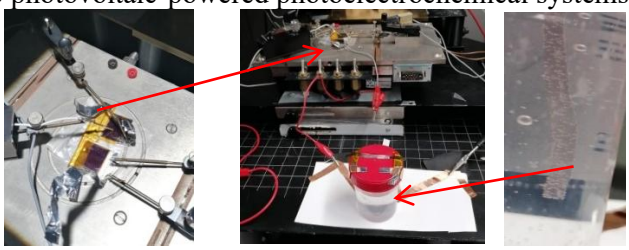

Fig. 1 Experimental setup (center) of an electrochemical cell with two nickel electrodes in 1M KOH solution (right) and two perovskite solar cells connected in series under light illumination using a solar simulator (left).

CONCLUSION

Preliminary studies have shown that optimized hybrid organic-inorganic halide perovskite solar cells can achieve water splitting with commercial electrodes. We then used perovskite solar cells by integrating them with a conventional/innovative catalyst and finally developed organic perovskite-based materials by encapsulation them in barrier polymers. The monolithic integration of these materials with electron and hole conductors and catalysts is the key to their integration into future hydrogen generators.

REFERENCES

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ACKNOWLEDGMENTS

This research was funded by the European Union - NextGenerationEU from the Italian Ministry of Environment and Energy Security, POR H2 AdP MEES/ENEA with involvement of CNR and RSE, PNRR - Mission 2, Component 2, Investment 3.5 "Ricerca e sviluppo sull'idrogeno", CUP: I83C22001170006.