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Defect-Engineered High-Entropy Spinel Oxide@Onion-Like Carbon Catalysts for High-Areal-Energy Rechargeable Zinc–Air Batteries

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Materials Electrochemistry
& Energy Technologies



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Introduction

The current-state-of-the art lithium-ion batteries are very expensive, unsafe and are fast approaching their maximum energy. Therefore, there is an urgent need for beyond lithium-ion batteries that can meet the energy demand of the consumer technologies. Rechargeable zinc-air batteries (RZABs) are considered as the next-generation sustainable energy storage technology with a huge potential to meet the SDG 7 and 12. However, the development of efficient and stable bifunctional (ORR/OER) electrocatalysts at high depth of discharge (DOD) remain a critical challenge. This novel work developed a highly efficient and stable bifunctional electrocatalyst for RZAB. The RZAB achieved $74 \text{ mWh cm}_{\text{geometric}}^{-2}$ exceeding the recommend threshold of $35 \text{ mWh cm}_{\text{geometric}}^{-2}$ at a current loading of 10 mA cm^{-2} .

RZABs

Advantages

- ❖ Safe
- ❖ Environmentally benign
- ❖ Low cost
- ❖ High energy

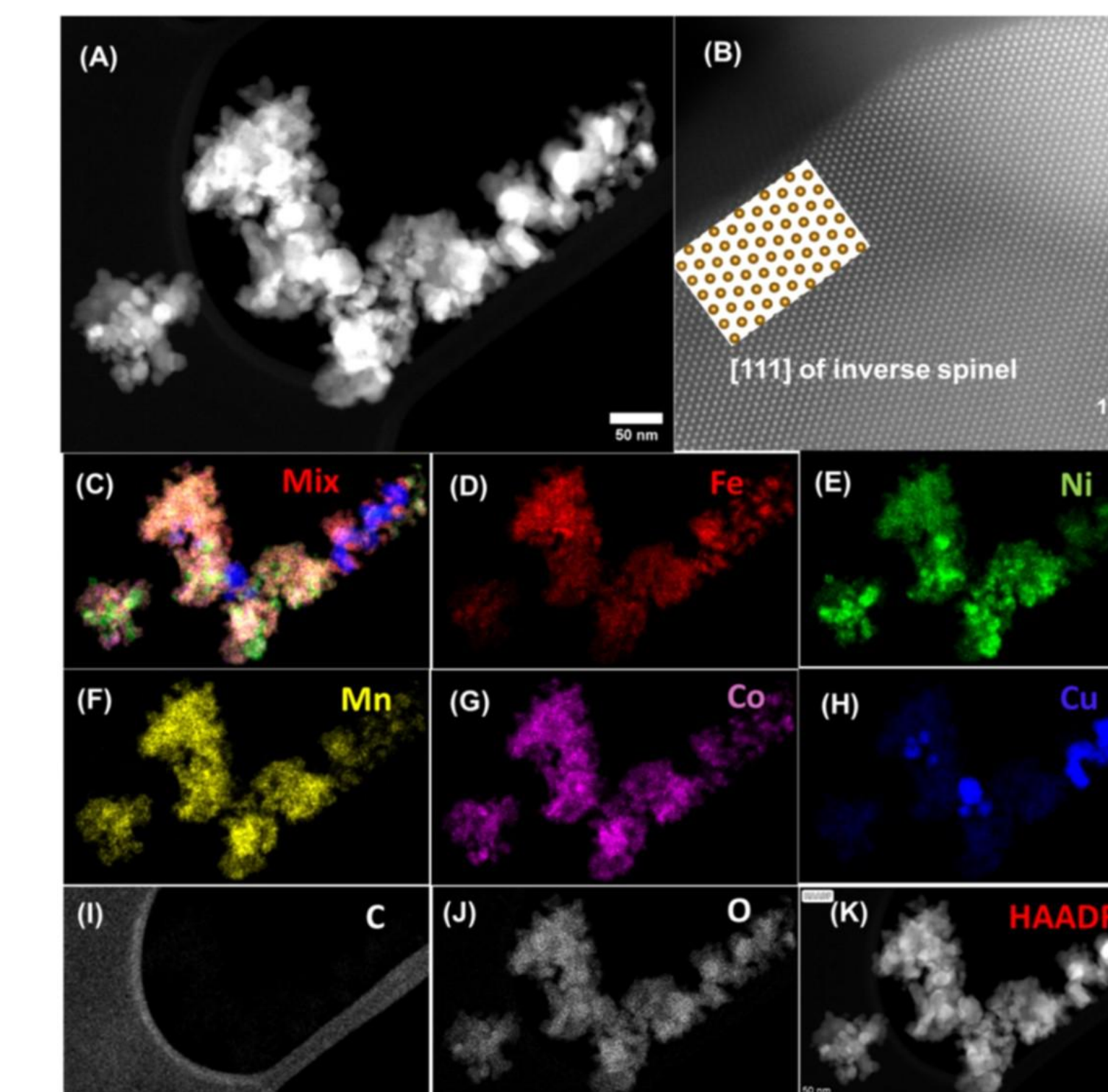
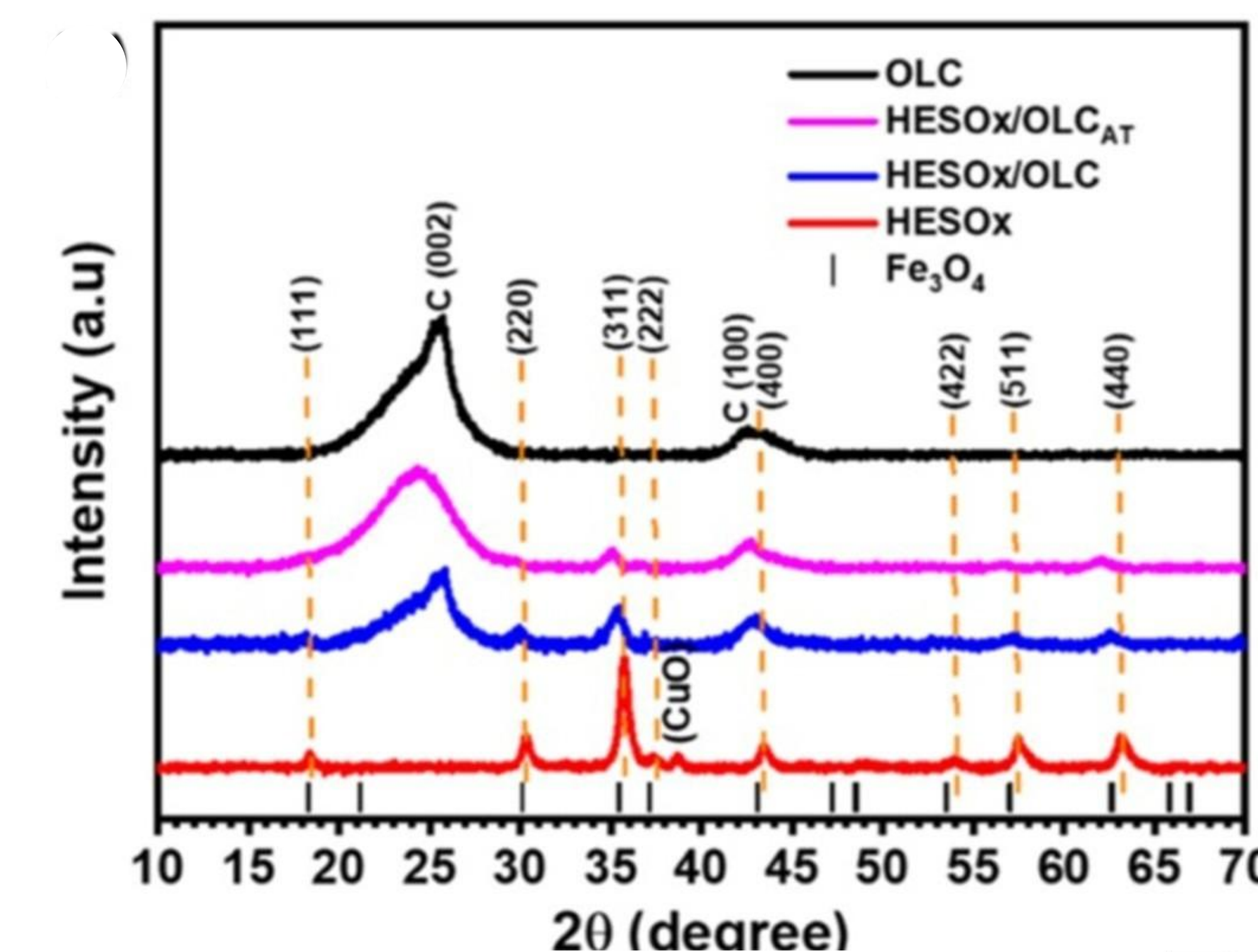
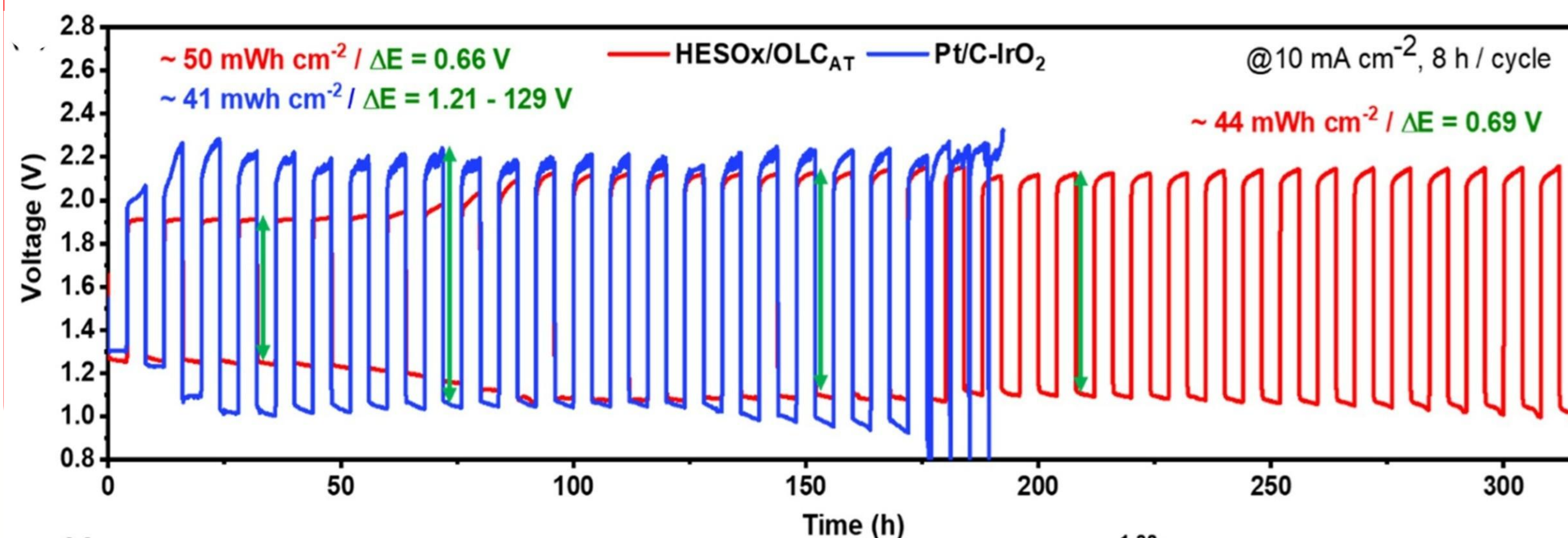
Challenges

- ❖ The development of efficient and stable bifunctional (ORR/OER) electrocatalysts at high depth of discharge (DOD))



Conventional Strategy

- ❖ 92% of reported ZABs with long cycle life are realized at low DOD



Conclusion:

- ❖ The RZAB studied in this work shows impressive deep DOD at 10 mA cm^{-2} (8 hr per cycle) with discharge areal energy of 50 mWh cm^{-2} and 44 mWh cm^{-2} after 300 hr cycles
- ❖ These results compare with, and are even better, than the best 8% articles that were reported to have met the minimum threshold for real technological applications

Reference:

- [1] Haruna A. B. et al. Energy Fuels 2025, 39, 13105–13119
- [2] Hopkins, B. J et al. Adv. Energy Mater. 2020, **10** (30), No. 2001287

