Pt-doped RuO_2 electrocatalyst for efficient and durable oxygen evolution in acidic media

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Abstract
The oxygen evolution reaction (OER) is crucial in energy conversion systems like water electrolysis, CO_2 reduction, and metal-air batteries.[1] It requires high energy to overcome kinetic barriers due to the four-electron transfer reaction.[2-4] In acidic electrolytes, OER offers a higher reaction rate, fewer side reactions, and better cell design, aided by polymer electrolyte membranes (PEM) that enhance proton conductivity and reduce gas crossover. Hydronium ions higher conductivity (350 S cm² mol^{-1}) than hydroxide ions (198 S cm² mol^{-1}) enables large current densities, emphasizing the need for cost-effective, durable OER catalysts for acidic media. Notably, Ruthenium oxide (RuO_2) is a promising OER catalyst in acidic media due to its activity and lower cost than Iridium oxide (IrO_2); however, it suffers from stability issues.[5] Doping strategies, such as introducing noble metals like platinum (Pt), have shown promise in enhancing RuO_2's performance and durability. Considering this, we employed a synergistic approach to develop Pt-incorporated RuO_2-based catalysts on Titanium (Ti) substrate using a viable electrodeposition technique, achieving simultaneous enhancement of intrinsic activity and stability. The Pt-doped RuO_2/Ti electrode demonstrates significantly enhanced OER activity in 0.1 M $HClO_4$ compared to the pristine RuO_2/Ti electrode, achieving notably lower overpotentials of 194 mV and 206 mV at 10 mA cm^{-2}, respectively. Experimental results indicate that incorporating Pt into the RuO_2 lattice increases oxygen vacancy concentration, promoting stronger interactions with reaction intermediates and reducing the energy barrier for OOH* formation. Furthermore, the enhanced activity is achieved without compromising stability, offering valuable insights for designing high-performance acidic OER catalysts and providing a foundation for practical applications in PEM electrolyzers.

References

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Figures

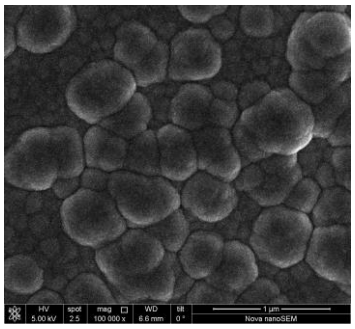

Figure 1: SEM image of Pt-doped RuO_2 catalyst.