Graphene vs. carbon black supports for Pt nanoparticles: towards next-generation cathodes for advanced alkaline electrolyzers

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The development of efficient and cost-effective water splitting electrolyzers is fundamental toward the path to reach climate neutrality by using renewable energy sources to produce green H^2 as a form of clean fuel. Here, we investigated Pt-based nanostructured cathodes for high-performance alkaline electrolyzers (AELs), showing the beneficial effect of graphene, over traditional carbon black, as nanocatalysts support. Surface-cleaned Pt nanoparticles were produced in aqueous environment and strongly anchored to defect-free graphene flakes, the latter produced through wet-jet milling exfoliation of graphite.[1,2] Pt/graphene catalysts outperform traditional Pt on Vulcan (Pt/C) in terms of hydrogen evolution reaction (HER) activity and performance durability.[3] The 2D morphology of graphene flakes strongly retains the catalysts in the electrode even in the absence of any binder, allowing the exposure of the catalytic sites for the HER. By using commercially available cost-effective anodes, our AELs reached current densities of 1 A cm^{-2} at a voltage of as low as 1.71 V and can even operate up to more than 2 A cm^{-2} (*e.g.*, 2.2 A cm^{-2} at 1.90 V), with stable performance during accelerated stress tests. Our study discloses two main aspects: 1) graphene is an effective conductive support[4,5] for nanocatalysts for the development of nanostructured cathodes, ensuting endurance performance; 2) the use of efficient nanostructured cathodes can boost the AEL's performance to state-of-the-art values reported for proton-exchange membrane electrolyzers, avoiding the use of expensive anodes (*e.g.*, Ir-based ones).

References

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Figures

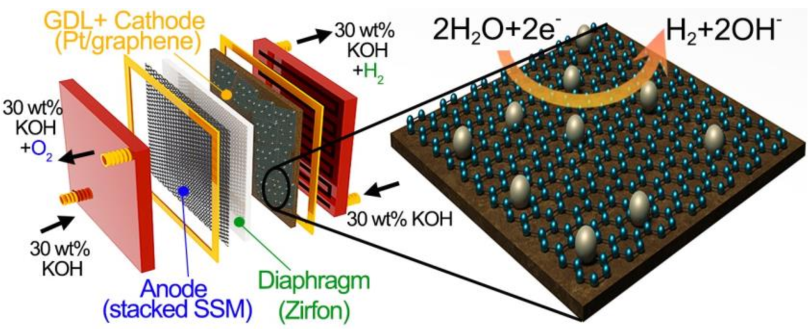

Figure 1: Sketch of our AEL, with Pt/graphene or Pt/C cathode, stacked SSMs anode and Zirfon UTP 220 diaphragm. Operating conditions: 30 wt% KOH electrolyte; atmospheric pressure (1 bar); 80 °C temperature.

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