Atomic Co decorated free-standing graphene electrode assembly for efficient hydrogen peroxide production in acid

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The past fifty years have seen a strong interest in the electrosynthesis of acidic hydrogen peroxide (H_2O_2) via oxygen reduction reaction (ORR) in both academia and industry because its advance can drastically benefit downstream environmental treatments.[1] However, up to now, the apparent activity of most electrocatalysts (especially in a flow cell reactor) still calls for improvement to meet the industrial demands which require a stably high H_2O_2 productivity with low energy input. In this talk, we will present a fresh free-standing ORR electrode design to achieve energy-efficient acidic H_2O_2 synthesis with a high production rate. This electrode comprises cobalt single atoms on vertically aligned graphene nanosheet assembly (CoN_4/VG), which exhibits a hierarchical porous structure that can maximize the utilization of catalytic active atoms without sacrificing the mass/charge transport efficiencies. Therefore, it can give a H_2O_2 selectivity close to 100% from 0.3 to 0.5 V versus reversible hydrogen electrode (RHE) in 0.1 M $HClO_4$ within H-cell setup, and sustain a record-breaking high H_2O_2 productivity of 706 $mmol_{H2O2}\ g_{catalyst}^{-1}\ h^{-1}$ at 0.3 V vs. RHE for 36 hours. When this electrode is introduced into an industrially relevant flow reactor, more promisingly, it can allow a peroxide concentration of 1100 mg L^{-1} (4000 $mmol_{H2O2}\ g_{catalyst}^{-1}\ h^{-1}$) continuously at -1.8 V of cell voltage corresponding to the energy consumption of 3.81 Wh g_{H2O2}^{-1}, which represents the most energy-efficient flow system for rapid H_2O_2 generation in acidic media.

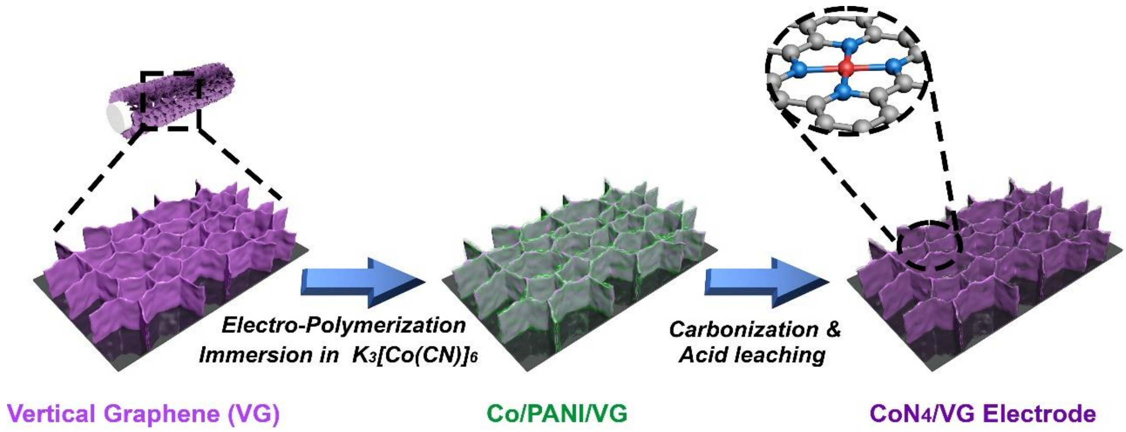

Figure 1: Electrode design for efficient hydrogen production in acid

References

[1] Brillas, E. *Chemical reviews* **2009**, 109 (12), 6570-6631.