Designed Synthesis and Assembly of Inorganic Nanomaterials for Energy and Catalytic Applications

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Recently we have focused on the architecture engineering of inorganic nanomaterials for their applications to electrocatalysis and photocatalysis. We present a synthesis of highly durable and active fuel cell electrocatalysts based on ordered M-Pt alloy nanoparticles for oxygen reduction reaction (ORR) in PEMFC. We synthesized highly active and stable electrocatalysts for hydrogen peroxide (H_2O_2) production including Co-N_4(O) moiety incorporated in nitrogen-doped graphene (Co_1-NG(O)) and cobalt phthalocyanine (CoPc) immobilized on oxidized carbon nanotube substrate. The electrocatalytic oxygen evolution reaction (OER) plays a pivotal role in the mass production of hydrogen fuel and chemical feedstocks by various electrochemical reactions. We report that early transition metals with vacant *d* orbitals (d^0-oxoanions) directly participate in and accelerate the alkaline OER via a redox cycle associated with early transition metal–peroxo species. We demonstrate that active machine-learning on even small datasets can discover a “champion” four-metal perovskite oxide OER catalyst. We report on the design and synthesis of highly active TiO_2 photocatalysts incorporated with site-specific single copper atoms that exhibit high photocatalytic hydrogen generation and CO_2 photoreduction activity. We presented a floatable photocatalytic platform constructed from elastomer-hydrogel nanocomposites, demonstrating its superiority over conventional systems in solar hydrogen production. We demonstrated a general method for synthesizing atomically dispersed catalysts via photochemical defect tuning for controlling oxygen vacancy dynamics.

References

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