Graphene-based Nanocomposites for Energy Storage and Conversion in Lithium Batteries, Sodium Batteries, and Fuel Cells

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Abstract

Due to their unique two-dimensional (2D) structure, unique electronic, thermal, mechanical, and chemical properties, together with their ease of synthesis and functionalization, graphene-based materials have been showing great potential in electrochemical energy storage and conversion [1,2].

In this talk, I will introduce the recent research activities in our group on graphene synthesis, functionalization (e.g., N-doping), and their applications in fuel cells, lithium-ion and sodium batteries, as well as wastewater treatment [3-7]. First, using the atomic layer deposition (ALD) technique, we fabricated isolated single Pt atoms anchored to graphene nanosheets. ALD offers the capability of precise control of catalyst size span from single atoms, subnanometer clusters to nanoparticles. The single-atom Pt/graphene catalysts exhibit significantly improved catalytic activity (up to 10 times) over that of the state-of-the-art commercial Pt/C catalyst. This work is anticipated to form the basis for the exploration of a next generation of highly efficient single-atom catalysts for various applications.

Very recently, we developed a facile, inexpensive and scalable wet-chemical strategy to fabricate the diamond-like Fe_3O_4/graphene composites. The nanocomposite shows dramatically enhanced electrochemical properties including splendid reversible capacity, superior cyclability and satisfactory rate performance for both lithium-ion batteries (LIBs) and sodium-ion batteries (SIBs).

References

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Figures

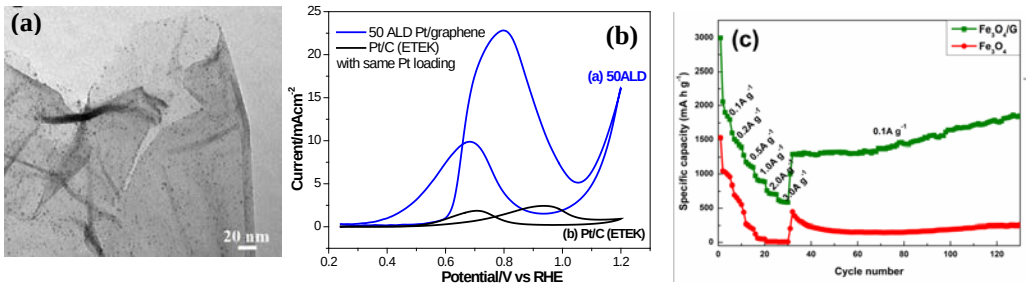

Figure (a) SEM image of Pt nanoparticles on graphene, (b) ALD Pt/graphene shows 10 times better activity for methanol oxidation than commercial Pt/C catalyst, (c) rate performance comparison of Fe_3O_4 and graphene supported Fe_3O_4 for LIBs.