Plasma-enhanced synthesis of nanomaterials for energy storage & conversion

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It has been known that the electrochemical properties are varied and even controlled by the surface or sub-surface status of materials. The reaction pathway guided by the surface binding energy with external ions or molecules play the role as the key factors for establishing the desired properties in the electrochemical energy storage and conversion such as supercapacitors and carbon dioxide (CO_2) reduction. A remarkable improvement in surface electrochemical properties of nanomaterials has been achieved through the plasma-enhanced processes on the surface of nanomaterials. Especially, the generating the hetero-atom doping sites and various type of defects on nanomaterials have been treated as the facile routs to establish the energy storage devices with high energy densities and the energy converting catalysts with high product selectivity.

In this seminar, I will discuss my recent research activities on development of nanostructured materials for electrochemical capacitors and electro-catalysts using the plasma processes. 2D carbon materials and their hybrid structure with nitrogen plasma doping were applied to various type of electrochemical capacitors from electrical double layer capacitors to hybrid capacitors. The increased binding energy between material surface to ions can be the major factor indicating the enhanced specific capacitance of capacitors. Transition metal based oxide materials with atomic defects and morphologies were also prepared by the plasma treatment and applied to the electro-catalysts for the CO_2 reduction reaction toward a useful chemicals and hydrocarbon fuels. Many advantages from plasma-enhanced processes on materials such as defects, porosity and ion pathway play a role as the key to success in designing the materials for energy storage and conversion with high performances. We expect that the method and applications demonstrated here could offer a possible route to obtain ideas for designing the high performance energy storage and conversion applications.

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