Artificial Photosystems : New Approach to the Synthesis of Boron-Doped Carbon Material from Plastic Wastes for Solar Energy Conversion Applications

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Waste plastics are the major cause of environmental pollution due to low-recycling rates. Herein, I demonstrate the first use of waste plastics as a source of carbon nanoparticles catalysis for artificial-nitrogen fixation cycle. Ammonia is an essential chemical in the N2 cycle that is widely used in agriculture and clean energy. This research proposes the generalized synthesis method for efficient photo-electrocatalysis for nitrogen reduction reaction (NRR) and azo-dyes photodegradation. The study consists of three experimental setups, as follow: (i) utilize inexpensive source of carbon poly(ethylene) and first liquid-phase thermal reduction of boronic acid, coordinate carboxyl groups at low carbonization temperature on poly(dimethylsiloxane) phase, (ii) I compared visible-light degradation of model dye methylene blue (MB) at 52 different B-doped carbon nanoparticle solutions and poly(ethylene) oxidized species with machine learning (ML) model, evidenced in FTIR, UV-Vis spectrophotometer and SEM/EDS images. (iii) I demonstrate B-doped carbon nanoparticles as an efficient metal-free N2 reduction photo-electrocatalyst. The B-doped carbon catalyst demonstrates excellent and selective activity at a doping level of 7.3%, and the Faradaic Efficiency (FE) of 8.62% at - 0.5 V vs. reversible hydrogen electrode (RHE) in acidic conditions. Developed functional carbon nano-structures will find many important uses in the future studies, from energy harvesting to monitoring environmental pollutants and energy storage.

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