High Performance Graphitic Carbon from Waste Polyethylene: Thermal Oxidation as a Stabilization Pathway Revisited

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In this study, thermal oxidation, which has only been considered as a degradation pathway for plastics, served as a simple and effective pre-treatment method to convert the chemical structure of 'non-carbonizable' linear low density polyethylene (LLDPE) for successful carbonization. Interestingly, LLDPE based carbon could be graphitized into a highly ordered graphitic carbon with exceptional electrical performance exceeding that of Super-P, a pricey reference conductive agent for lithium ion battery fabrication. Upon thermal oxidative pre-treatment, inherently non-carbonizable LLDPE was successfully transformed into an ordered carbon through heat treatment with a high conversion yield reaching 50 %, a yield comparable that obtained from polyacrylonitrile (PAN), a reference polymeric precursor. Systematic interrogation of the chemical structural evolution using XRD, Raman, and DSC analysis, confirmed that an oxidation reaction initiated transformation of aliphatic chains into cyclized ladder structures. The thermally oxidized LLDPE evolved into a highly graphitic carbon that exhibited superior degree of ordering and electrical performance.