Degradation of Polyethylene and Poly(Ethyl Cyanoacrylate) via Photothermal Heating

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Localized surface plasmon resonances in metal nanoparticles generate intense localized heat, which can be used to catalyze reactions. This study aims to use plasmonic silver nanoparticles to photothermally catalyze the decomposition of two polymers: low-density polyethylene and poly(ethyl cyanoacrylate). Previous photothermal heating studies have been conducted under high-intensity laser irradiation. However, this study instead uses an array of 450nm LED lights to study polymer degradation over extended periods, ranging from 24 to 120 hours. Mechanical testing on poly(ethyl cyanoacrylate) show breaking stress and strain reduction of up to 75% in the presence of nanoparticles. Although low-density polyethylene does not show significant changes in mechanical strength in the studied timeframe, spectroscopic testing results shows weakening in its polymer structure in the presence of nanoparticles. Overall, the results of this experiment show significant degradation from photothermal heating in both polymers studied. Future research in photothermal polymer degradation could lead to the development of new, sustainable plastics which degrade in marine environments.