

Studies on Toxicity and Mechanical Properties of Nonmetallic Printed Circuit Boards Waste in Recycled HDPE Composites

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Abstract : The aim of this study was to investigate the suitability of reusing nonmetallic printed circuit boards (PCBs) waste in recycled HDPE (rHDPE) in terms of toxicity and mechanical properties. A series of X-ray Fluorescence Spectrometry (XRF) analysis tests have been conducted on raw nonmetallic PCBs waste to determine the chemical compositions. It can be seen that the nonmetallic PCBs approximately 72% of glass fiber reinforced epoxy resin materials such as SiO₂, Al₂O₃, CaO, MgO, BaO, Na₂O, and SrO, 9.4% of metallic materials such as CuO, SnO₂, and Fe₂O₃, and 6.53% of Br. Total Threshold Limit Concentration (TTLC) and Toxicity Characteristic Leaching Procedure (TCLP) tests also have been done to study the toxicity characteristics of raw nonmetallic PCB powders, rHDPE/PCB and virgin HDPE for comparison purposes. For both of the testing, Cu was identified as the highest metal element contained in raw PCBs with the concentration of 905 mg/kg and 59.09 mg/L for TTLC and TCLP, respectively. However, once the nonmetallic PCB was filled in rHDPE composites, the concentrations of Cu were reduced to 134 mg/kg for TTLC and to 3 mg/L for TCLP testing. For mechanical properties testing, incorporation of 40 wt% nonmetallic PCB into rHDPE has increased the flexural modulus and flexural strength by 140% and 36%, respectively. While, Izod Impact strength decreased steadily with incorporation of 10 - 40 wt% nonmetallic PCBs.

Keywords : nonmetallic printed circuit board, recycled HDPE, composites, mechanical properties, total threshold limit concentration, toxicity characteristic leaching procedure

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