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Recovery of Particle Reinforced Composite 3D Printing Filament from Recycled Industrial Polypropylene and Glass Fibre Waste

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Extended Abstract

The use of fibre-reinforced polymer composites has increased in recent years across various industries, such as aircraft, energy, sports, infrastructure, medical, defence, electronics, and automobile industries [1]. In particular, carbon fibre reinforced polymers (CFRP) and glass fibre reinforced polymers (GFRP) [1, 2] regularly demonstrate favourable strength-to-weight ratios at multiple size scales. Until recently, these materials have been readily adopted without complete consideration of the environmental impacts of the entire life cycle of the product- from raw material extraction, production, use and end-of-life outcome. In addition, composite waste occurs during production processes. Thus, finding efficient, commercially viable and effective reuse, remanufacturing and recycling routes is now of crucial importance to ensure sustainable continued use of composites. In addition, it is imperative that every effort be made to reduce the amount of waste material that is either disposed of or incinerated by reusing and recycling material to the greatest extent possible. Two examples of where waste fibre-reinforced polymer composites are produced in significant quantities worldwide are in wind turbine blades and drone structures [2, 3].

The aim of this paper is to develop low-cost raw feedstock and products out of waste composite material, while retaining as much as possible of the mechanical advantage that composites provide. In contrast to thermoset resins, which are difficult to recycle and dispose of, thermoplastic matrix resins are easy to recycle since they are typically remeltable [4]. To explore recycling technologies and protocols, sample off-cut fabrics of glass fibre-reinforced polypropylene (GFRPP) were obtained from a composite manufacturer. A selection of pure and particle reinforced composite 1.75mm filaments compatible with standard material extrusion additive manufacturing (3D Printing) hardware were produced. The mechanical properties of GFRPP filaments were assessed through filament testing. Different volume fractions of short fibre were manufactured by varying the ratio of polypropylene to glass fibres. Thermal analysis will be conducted on both GFRPP and GFRPP filaments to confirm the glass transient temperature and secondary polymer crystallization (due to residual stresses in the filament manufacturing process). Thus key process parameters (e.g. extruder temperature) on the ultimate strength will be determined.

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