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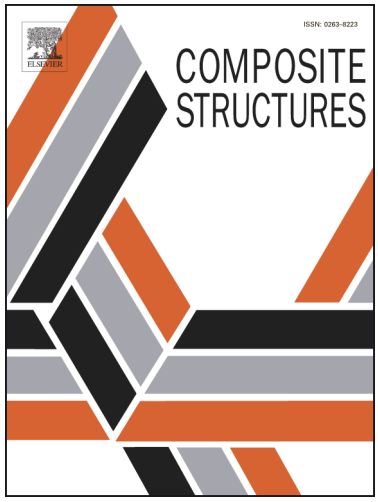

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On the recyclability of polyamide for sustainable composite structures in civil engineering

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ABSTRACT

Previous studies have highlighted the potential application of Polyamide 6 (PA6) as excellent recyclable polymeric material, which is well suited to form carbon-fiber-reinforced, graphene-nanoplatelets-reinforced or metal-porous-polymer composite structures. The conventional screw extrusion process is one of the established melt processing techniques, having potential of enhancing mechanical, thermal and morphological properties of polymeric materials. PA6 is an important engineering material which exhibits excellent mechanical properties, chemical resistance, wear resistance, dimensional stability, and low coefficient of friction. In the present study attempts have been made to explore the behavior and characteristics of the recycled PA6 polymer through twin screw extrusion process towards increase in recyclability (as primary recycling process). The mechanical properties (tensile strength, Young's modulus, peak load), metallurgical properties (porosity, wear and material loss) supported with optical microscopy were investigated to ensure the recyclability of PA6 as a properties enhancing extrusion process. It has been observed in the present study that, melt processing by screw extrusion at best settings of input process parameters enhances the material properties for applications in sustainable civil engineering.

Keywords: Polyamide, recycling, mechanical properties, wear, screw extrusion, composite structures, civil engineering

1. Introduction

Polyamide 6 (PA6) is being increasingly considered as a convenient matrix material in light-weight carbon-fiber-reinforced, graphene-nanoplatelets-reinforced structures or reinforcing fibers of cement mortars [1-4]. The recycling of such a material is attracting increasing attention, on considering that several advances have been made in the technology for recycling of plastic solid waste over the last 20 years [5]. Polymer recycling is majorly sub-divided in either chemical recycling or mechanical recycling. De-polymerization by chemical recycling is a way to replay original monomers [6]. However, complexity of systems and high cost of operation are some of difficulties of this method. The burning of polymers to recover energy is used too. In this situation, environment benefits are questionable [7]. So, chemical recycling is not considered as a reliable technique for feedstock preparations because of hazards and uneconomical processing, so mechanical recycling process is often preferred as feedstock preparations of fibrous polymer like PA6. Mechanical recycling is an interesting alternative which can combine technical viability, acceptable costs and environmental benefits. The contamination with impurities and others polymer as well as the degradation of material are the main difficulties for this method of recycling of polymers [8]. Mechanical recycling process is usually responsible for the reduction in mechanical properties such as tensile or impact strength, but this process is capable for preparing material that yield for the melt compounding and processing (e.g. fused deposition modeling, injection molding and compression molding). The PA6 is a semi-crystalline engineering thermoplastic with good mechanical properties, but suffers from high moisture uptake, poor resistance to thermal oxidation and UV radiation, and low impact strength under low-temperature or dry condition

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