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EFFECT OF FUSED TECHNIQUE TO THE DENSITY AND MECHANICAL PROPERTIES OF THE NYLON 12 FILLED EPOXY COMPOSITES

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ABSTRACT

In polymer composites, fillers like Nylon are often added to improve mechanical and physical properties. However, the presence of filler-filler interactions can lead to agglomeration, creating voids that weaken the composite's strength. To address this issue, a fusion technique was applied in this study to reduce void formation and improve the overall performance of Nylon-filled epoxy composites. Two types of Nylon powders, Nylon SP301 (pure Nylon) and Nylon SP305CF (Nylon with Carbon Fibers), were used in varying weight percentages (3%, 6%, 9%, 12%, and 15%). The fusion technique involved heating the cured composites at specific temperatures and times. The density results showed that Nylon SP305CF/Epoxy composites had slightly higher densities (1.15 g/cm^3 to 1.12 g/cm^3) than Nylon SP301/Epoxy composites (1.14 g/cm^3 to 1.11 g/cm^3) due to the presence of carbon fibers. At 195°C, the density of SP305CF composites decreased more, as the carbon fibers interfered with the fusion of Nylon particles, causing voids. A larger density reduction occurred at 205°C. The mechanical properties showed that the elastic modulus and stress of Nylon SP301 composites increased after fusion, with stress relaxation fluctuating depending on filler loading. SP305CF composites, while inconsistent due to carbon fibers, generally exhibited higher elastic modulus and stress than SP301 composites. The DSC analysis indicated that at 195°C, the glass transition temperature (Tg) of both Nylon and epoxy increased with fusion time, especially in SP301 composites, reflecting increased stiffness. In SP305CF composites, the presence of carbon fibers caused fluctuations in Tg. At 205°C, the Tg values of Nylon and epoxy in SP301 composites converged, suggesting better material compatibility with longer fusion time. A fusion temperature of 205°C for 20 minutes was selected for further study as it provided more complete fusion, especially at higher filler loadings, compared to 195°C where incomplete fusion and residue were observed. The 15% filler loading was identified as optimal for achieving the best fusion results.

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CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Materials need to have good properties involving density, stiffness, strength, and lower cost with increased sustainability in the era of rapid growth in the manufacturing industries. Composite materials precisely have this kind of property. A long time ago, many of the conventional materials such as metals have been replaced by polymers in various applications due to benefit provide by polymer is more rather than conventional materials (Yashas Gowda et al., 2018). Based on the engineering application viewpoint, polymers are one of the classes of materials that indicate excellent properties. Polymers are light in weight and low in strength but have high corrosion resistivity. To get over this downside, the soft polymer matrix is reinforced by hard secondary phase material which results in the improvement of thermal and mechanical properties. Fillers or fibre types which commonly inert are used as hard phase materials (Kumar Singh et al., 2018).

Polymer composites are made up of two or more constituents which are chemically insoluble and have different properties. Normally, polymer composites consist of a polymer matrix and a reinforcement material. The polymer matrix is a continuous phase that surrounds and supports the reinforcement material, which provides additional strength, stiffness, and other desired properties to the composite material. Reinforcement, on the other hand, is a material which is added to a polymer matrix because of their specific properties such as thermal conductivity, thermal stability, strength, and others. Reinforcements can be in the form of fibres and particulates where each has their own advantages and disadvantages. Few advantages of particulates filler over fibre reinforcement are easy to handle and disperse leading to a more homogenous distribution of reinforcement through the composite's material, besides of lower anisotropy where this can be advantageous in some applications where isotropic or near-isotropic properties are desired (Deo, 2010). Moreover, filler addition into composites will enhance hardness, toughness, heat distortion temperature and stiffness significantly (Kiran et al., 2018).