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RESEARCH ARTICLE

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Investigating the mechanical properties and microstructure of the weld joint obtained by laser welding of PA12/CNT nanocomposites

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Abstract

In this article, the 3D printed polyamide12/carbon nanotube (PA12/CNT) nanocomposites were joined using laser welding. The factorial design method was applied to study the effect of laser power, welding velocity, and CNT content on the tensile and impact strengths of welded samples. The differential scanning calorimetry and thermogravimetric analysis were also used to measure the thermal stability and weight loss temperature of the nanocomposite. The results indicated that the increase of CNTs enhanced the thermal stability of the nanocomposite and so increased its melting point and crystallinity percentage. The impact and tensile strengths of the weld enhanced when laser power elevated from 40 to 50 W, but elevation of laser power up to 60 W decreased the impact and tensile strengths due to thermal degradation of the nanocomposite. A rise in welding velocity from 10 to 20 mm/s enhanced the tensile strength, while the impact strength initially enhanced and then decreased. The highest tensile strength obtained at 2 wt% CNT, whereas the addition of CNTs up to 4 wt% led to their agglomeration, which resulted in the reduction of impact and tensile strengths. Finally, the optimal conditions for concurrent increase of impact and tensile strengths include the laser power of 51 W, welding velocity of 12.5 mm/s, and CNT content of 2.3 wt%.

KEYWORDS

fused filament fabrication, laser welding, mechanical properties, PA12/CNT nanocomposite, thermal properties

1 | INTRODUCTION

Polymer composites have different applications in automotive, airplane, electronic, and packaging industries for enhancing the manufacturing efficiency and reducing the cost of the products.[1–3] In recent years, polyamide (PA) has attracted enormous attention, owing to its good processability, high mechanical properties, and high thermal stability.[4–7] Among the various polyamide grades, polyamide 12 (PA12) has found significant applications in different industries, because it has good dimensional stability, small shrinkage rate, easy processing, and low melting point.[8,9] In order to increase the mechanical and thermal properties of PA12, it was recommended to add a small amount of filler like carbon nanotube (CNT).[10,11] The CNT is an ideal reinforcing filler because of its excellent thermal, electrical, and mechanical properties making them one of the most important

