RESEARCH ARTICLE

# 3D printing polypropylene composites reinforced with functionalized halloysite: Balance between stiffness and impact resistance

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## Abstract

In this work, a new nano-reinforced polypropylene filament was produced and fabricated by 3D printing to create a nanocomposite with a good balance between stiffness and impact resistance properties. Nanocomposite filament with 0.5, 1.0, and 1.5 wt% of functionalized halloysite nanotubes was prepared. The chemical modification was carried out to obtain a reinforcement that could act as an improved β-nucleating agent and characterized by infrared spectroscopy. The spectrum showed the appearance of two new bands at 1571 and 1410 $cm^{-1}$, which could indicate an interaction between the pimelic acid molecules and the oxygenated surface of the halloysite nanotubes. Energy dispersive X-ray spectroscopy analysis confirmed a good dispersion of the modified reinforcement along the surface of the nanocomposite filament. Wide-angle X-ray scattering and differential scanning calorimetry analyses showed the improvement of the β-nucleating ability of the halloysite nanotubes through new chemically functionalized, obtaining percentages of β-crystal of 80% for the nanocomposite reinforced with 0.5 wt%. The dynamic mechanical analysis showed that the 3D-printed functionalized nanocomposites presented higher storage and loss modulus (an increase of 148% and 122%, respectively). Finally, the impact strength properties increased by 90%, 108%, and 21% for the functionalized nanocomposites with 0.5, 1.0, and 1.5 wt%, respectively.

## Highlights

- Chemical functionalization of a natural reinforcement as a -nucleating agent.
- 3D printing polypropylene nanocomposites with enhanced properties.