Control of Biodegradability in a Natural Fibre Based Nanocomposite as a Function of Impregnated Copper Nanoparticles

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ABSTRACT

The properties of biodegradability or non-biodegradability are highly important for the design and application of sustainable materials. The objective of this work is to introduce a novel type of nanocomposite comprising a natural fibre reinforcing agent impregnated with copper nanoparticles, and to control the biodegradability of this sustainable material using the function of the impregnated copper nanoparticles. At room temperature, copper nanoparticles were synthesized and impregnated into palm oil fibre to improve the strength and durability of the fibre and the material properties of the composite. Fourier transform infrared spectroscopic techniques were used to characterize the prepared composites. The biodegradability (minimum to maximum boundary) of the composite was studied (using the soil burial test) as a function of the quantity of copper nanoparticles, where the tensile strength was fixed at the maximum. The property of biodegradability was also optimized with the help of response surface methodology. The biodegradability of the developed composites ranged from 26.72 to 6.51% when the concentration of impregnated copper nanoparticles was varied from 0 to 2590 μg g^{-1} respectively. The results indicate that copper nanoparticles can be considered as a potential biocide in composite materials and in this work for controlling the biodegradability of the material by varying the quantity of impregnated copper. The relationship between the responses and variables selected in this study has been justified by the predicted models. Moreover, the model terms have been explained and the prediction has also been performed successfully. Thus, copper nanoparticles have been successfully applied for controlling the biodegradability of the nanocomposite materials. The prepared nanocomposite materials are considered for both indoor and outdoor applications. This study is quite promising for controlling the biodegradability of advanced materials, especially when the degree of biodegradability is so important for their respective applications.

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