Eco-friendly 3D printed polymer composite parts made from chitosan of terrestrial insects

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An international interdisciplinary team of researchers from India, Malaysia, Singapore and Thailand has successfully developed a method

of using chitosan from terrestrial insects to manufacture eco-friendly polymer composite parts using the 3D printing method.

3D printing is a form of additive manufacturing technology that is becoming increasingly popular in recent times due to its ability to produce complex shapes and geometries that were difficult to achieve using traditional manufacturing techniques. As a result, the demand for raw material for 3D printing is on the rise. It is crucial to ensure responsible usage of raw materials for 3D printing to meet the UN Sustainable Development Goal 12, i.e., promoting sustainable consumption and production patterns.

Chitosan is a natural biopolymer that is derived from chitin, a polysaccharide found in the exoskeletons of arthropods such as insects, as well as in sea creatures such in the shells of crabs. Terrestrial insects are a potential source of chitosan due to their abundance, accessibility, and relatively high chitin content in their exoskeletons. There are several potential benefits to extracting chitosan from terrestrial insects, including sustainable and eco-friendly production.

Insects are a sustainable source of chitosan, as they can be easily farmed and harvested in large quantities without contributing to environmental pollution. In contrast, traditional sources of chitosan such as shrimp and crab shells can be unsustainable and have negative environmental impacts. However, how best to use chitin and chitosan materials derive from terrestrial insects remains debatable.

This study has investigated the feasibility of developing an environmentally friendly composite material using 3D printing technology. The study found that the addition of chitin and chitosan, derived from terrestrial insects, to the PLA matrix led to a decrease in strength and stiffness, which worsened with increasing concentrations of chitin and chitosan. The composite material with 0.5 wt% chitin

reinforcement had the lowest tensile and flexural strength compared to other composites produced using additive manufacturing.

The reduction in strength and stiffness of the chitin/PLA and chitosan/PLA composites, in comparison to neat PLA, was attributed to the decreased interfacial bonding between the reinforcement and matrix. This resulted in polymeric slippage when the composite was subjected to an external load. However, the chitin/PLA and chitosan/PLA composites demonstrated enhanced ductility relative to neat PLA, with the 0.1 wt% chitin composite showing the highest ductility. It was concluded that chitin and chitosan could contribute to toughening the PLA composite.

The study also found that the density of the composites increased with increasing concentrations of chitin and chitosan. FTIR and XRD analyses confirmed the crystalline and chemical bonding nature of the composite samples. Microstructural examination showed voids and impurity-like particles associated with chitin and chitosan decomposition in the composites. The Chitin/PLA and Chitosan/PLA composites exhibited good thermal stability, and could have potential applications for food product packaging based on their compressive properties.

Further research is needed to investigate interfacial bonding and post-treatment processes to improve the mechanical characteristics of the composites and scalability of the method for industrial production. One thing for sure, using the chitosan (chitin) derived from terrestrial insects as a material for making filaments for 3D printing of parts could lend to a low carbon way of meeting the UN Sustainable Development Goal 12, i.e., promoting sustainable consumption and production patterns.

More information: Bright Brailson Mansingh et al, Characterization and Performance of Additive Manufactured Novel bio-waste Polylactic acid eco-friendly Composites, *Journal of Polymers and the Environment* (2023). DOI: 10.1007/s10924-023-02758-5

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