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3D printing with nanocellulose polymer composites

Rigoberto C Advincula
National University of Malaysia (UKM), Malaysia

3D printing as a form of additive manufacturing has a number of advantages on on cost, speed, accuracy, complexity in design, and flexibility of manufacturing. They have attracted several new applications in various industries especially in the field of medicine where customized solutions are highly called for. Although this modern fabrication technique offers several benefits, it also poses critical challenges in materials development – specifically in thermo-mechanical properties. Proliferation of polymers in biomedical application has been severely limited by their inherently weak mechanical properties despite their other excellent attributes. A number of these polymers include PLA and PCL based materials. Earlier works on 3D printing of polymers focus mainly on biocompatibility and cellular viability and lack a close attention to produce robust specimens. Nanocomposite polymer materials possess superior mechanical strength and inherent stiffness. The addition of nanocellulose or cellulose nanocrystal (CNC) has been known to improve tensile strength in materials. In our work, the CNC from abaca plant is incorporated to provide the necessary toughness for 3D printable biopolymer. We have demonstrated 3D printing of CNC-filled biomaterial with significant improvement in mechanical and surface properties. These findings may potentially pave the way for an alternative option in providing innovative and cost effective patient-specific solutions to various fields in medical industry. To the best of our knowledge, this work presents the first successful demonstration of 3D printing of CNC nanocomposite hydrogel via stereolithography (SL) forming a complex architecture with enhanced material properties potentially suited for tissue engineering.

rca41@case.edu