Development of a Sustainable Metal-infused Polymer Compatible with Low-cost Fused Deposition Modeling 3D Printers

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ABSTRACT

Additive manufacturing has been employed to fabricate metallic parts for years; however, prevalent techniques are expensive and energy-consuming. Therefore, fused deposition modeling (FDM) technique has grabbed the attention of researchers and industries in recent years. Despite the promising results so far, available materials for metal FDM 3D-printing are very limited. The current study presents the development of a novel metal-infused polymeric feedstock for FDM 3D-printing, consists of carbonyl-nickel and polylactic-acid (PLA). A low-cost desktop 3D printer is employed to produce green parts; subsequently, debinding/sintering processes can be conducted to achieve a fully metallic part. The low-cost carbonyl-nickel powder, that has been used in this study, is produced using the low-carbon footprint process, Mond process, with a significant application in production and recycling of nickel and iron-based batteries. Furthermore, PLA is chosen because it is bio-based and biodegradable with a lower carbon footprint in the carbon cycle than fossil-fuel-derived polymers. Therefore, the whole process is an ecofriendly cycle, stepping toward the sustainable and affordable production of metallic components. Regarding development of a novel feedstock material compatible with 3D-printing, it is important to understand its properties. So, the developed feedstock materials are rheologically and physico-mechanically analyzed to find the optimum filler concentration.