NOVEL 3D PRINTED NANOCELLULOSE DERIVED FROM OPUNTIA FICUS INDICA AS BIOTEMPLATES FOR ZnO IN SITU GROWING

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Cellulose nanofibrils (CNFs) extracted from Opuntia Ficus Indica (nopal) were successfully isolated to obtain a printable bio-ink for 3D direct ink writing (DIW) in combination with sodium alginate. Rheological characterization of the bio-ink showed the shear thinning behavior and yield stress, under stationary and oscillatory state, respectively. Rectangular meshes were obtained by DIW under different printing parameters, and were used as biotemplates for ZnO growing. Using Scanning Electron Microscopy (SEM) different ZnO morphologies, as rods, hexagonal rods, nuts, spheres, ovals, sheets, and hexagonal sheets were obtained by in situ growing over the 3D printed biotemplates using three synthesis methods; hydrothermal growth, chemical precipitation method by chemical bath, and seeding process. The combination of these last two methods with the addition of Triethanolamine (TEA) as a complex agent, and varying the salt precursor and its concentration allowed a complete and homogeneous coating without damaging the cellulose templates, presenting hexagonal nut-shaped (~1µm diameter) and oval-shaped (~400 nm length) ZnO particles. The XRD patterns confirmed the wurtzite crystalline structure, and Fourier Transform Infrared spectroscopy (FTIR) also confirmed the coatings. The content of Zn in the 3D printed decorated biotemplates was obtained by ICP and showed almost 50 wt %. To the best of our knowledge, there is a lack of reports about immobile substrates for ZnO growing, only a few previous studies have synthesized powdered ZnO materials onto cellulose fibers. These novel sustainable 3D printed and decorated biotemplates are flexible in aqueous media facilitating their implementation in different systems, making them powerful materials for advanced photocatalytic applications.

Keywords: Cellulose, 3D printing, ZnO

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