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Tailoring mechanical properties of printed GelMA scaffolds with multilayers of PLA/Laponite nanocomposite fibers

Silva, M.S.(1); De Sousa, G.F.(1); Das Virgens Santana, M.(1); Tsumura, W.G.(2); Stocco, T.D.(2); Lobo, A.O.(1);
(1) UFPI; (2) Unibrasil;

Scaffolds are three-dimensional structures that provide support and can stimulate cell growth in the medium in which they are inserted, thus providing the necessary support while the tissue regenerates. This study focuses on fabricating and evaluating hybrid scaffolds of printed GelMA hydrogels reinforced with multilayers of Poly(Lactic Acid) (PLA)/Laponite (LAP) microfibrous membranes. PLA microfibers with varying amounts of LAP (0, 1.0, 2.5, and 5%) were synthesized using rotary-jet spinning and electrospinning after that were subjected to oxygen plasma treatment. Scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), and x-ray diffraction (XRD) were utilized for morphological and compositional analyses. Other tests were injectability, fiber diameters, and contact angle, to determine solution specifications. Their mechanical properties were evaluated via uniaxial tensile testing, highlighting improved mechanical strength by incorporating LAP, particularly in the PLA/ LAP 2.5% was the best group using rotary-jet spinning, and PLA/LAP 5% of electrospinning. The electrospinning synthesized group presented the smallest diameter and better results in tensile strength. Then, the microfibrous membranes were integrated into printed GelMA hydrogel layers, creating GelMA-PLA/LAP hybrid scaffolds, whose interaction and integrity were confirmed through SEM. Mechanical assessment via uniaxial compression tests demonstrated a significant enhancement in the mechanical properties of the hybrid scaffolds attributed to the inclusion of microfibrous membranes, the groups of electrospinning presented better results tensile strength compression strength. These findings underscore the potential utility of GelMA-PLA/LAP scaffolds in tissue engineering applications by capitalizing on the mechanical reinforcement imparted by PLA/LAP microfibrous layers. After that, the scaffolds were printed at a cryogenic temperature of about -20°C with the inclusion of the best groups of microfibrous by rotary-jet spinning and electrospinning, this temperature variation promotes the increase in the compressive strength result compared to the other group printed in room temperature. The results support the development of research in this area and the investigation of printing at low temperatures due to improved mechanical properties in soft tissues.