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Abstract

The New Era of Additive Manufactured Orthopaedic Devices: Materials and Their Mechanical Performance †

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Orthoses are medical devices applied externally to improve performance in patients with difficulties and/or disabilities, designed to provide support, stabilization, and immobilization [1,2]. Specifically, customized orthoses are the most appropriate treatment for pathologies in the upper or lower limbs, offering the benefit of individualized treatment [3].

When designing customized orthoses, the choice of material to be used is relevant. Important features such as strength, stiffness, durability, density, and resistance to corrosion must be considered. Most recently, the use of Additive Manufacturing appeared as a solution to build custom orthotics in an easier and faster way. For this, we evaluated the use of Fused Deposition Modelling to produce custom orthotics. Several materials commonly used in FDM were assessed, such as: acrylonitrile styrene acrylate (ASA), Nylon 12, polycarbonate (PC), polycarbonate/acrylonitrile butadiene styrene (PC-ABS), polyethylene terephthalate glycol (PETG), polylactic acid (PLA), thermoplastic polyurethane (TPU), ULTEM 1010™, and ULTEM 9085™. Different parameters (yield stress, Young's modulus, and elongation at break) were assessed upon compression, flexion, and tensile mechanical testing according to ASTM D–695, ISO 178, and ASTM D638-14, respectively. Overall, the results show that PLA, PETG, ULTEM 1010, and ULTEM 9085 are the most suitable materials with the best properties for the production of the proposed orthoses, ensuring their stability and performance.

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