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Stress Relaxation and Creep Behaviour of Material Jetting Parts †

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Nowadays, more than design considerations, traditional manufacturing technologies prove to be a real obstacle to the development of more efficient structures. In this context, additive manufacturing (AM) emerges as a promising technique and is associated with the process of adding and joining material, layer by layer, to form a part. In this context, it is possible to create three-dimensional objects directly from CAD models [1]. According to the American Society for Testing and Materials (ASTM), this technology is divided into seven groups: (1) vat photopolymerization, (2) powder bed fusion, (3) material extrusion, (4) material jetting, (5) sheet lamination, (6) binder jetting, and (7) directed energy deposition [2,3].

Considering only the material extrusion group, fused filament fabrication (FFF) is the most widely used process, which is based on the extrusion of heated feedstock plastic filaments through a nozzle to deposit layers onto a platform to produce parts layer by layer directly from a computer-aided design model. However, despite the benefits inherent to this technique, it is not possible to omit some disadvantages, essentially aging faster under UV exposure and lower mechanical properties. However, despite the benefits inherent to this technique, such as simplicity, low cost and possibility of printing parts involving different multi-materials, it is not possible to omit some disadvantages, essentially aging faster under UV exposure and lower mechanical properties and dimensional tolerances [4–6].

In this context, material jetting is considered one of the most accurate 3D printing technologies, which have a dimensional accuracy of ±0.1%. With it, objects are created in a similar method to a two-dimensional ink jet printer. Material can be jetted continuously or only when required, because it is selectively jetted onto the build platform and cured by ultraviolet light or heat to form a 3D component. However, in most cases, the material is a photosensitive resin that cures under ultraviolet light.

Therefore, this study intends to perform a mechanical characterization of a VeroWhitePlus resin, which is a rigid and durable material suitable to use in a wide range of industries, namely, to produce highly accurate part models, smaller parts with complex features, electronic housings, and medical devices and components. Nevertheless, as a consequence of the inherent viscoelasticity of the polymers, this study will focus on stress relaxation and creep behaviour, phenomena that must be understood especially for long-term applications. For this purpose, the tensile strength of this material was obtained, and in the domain of its elastic regime, stress relaxation and creep tests were performed. This study focuses on short-term tests, however, they are an easy, fast and reliable method to predict long-term behaviour. In this context, to predict the viscoelastic response for long exposure times, several models were compared with the experimental results in order to select the one that best predicts provides. It was possible to conclude that the Kohlrausch–Williams–Watts (KWW) function can be used to accurately predict the viscoelastic response, both in terms of stress relaxation and creep.

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