Changes in molecular structure and mechanical properties in EB-irradiated 3D-printed materials produced by SLA

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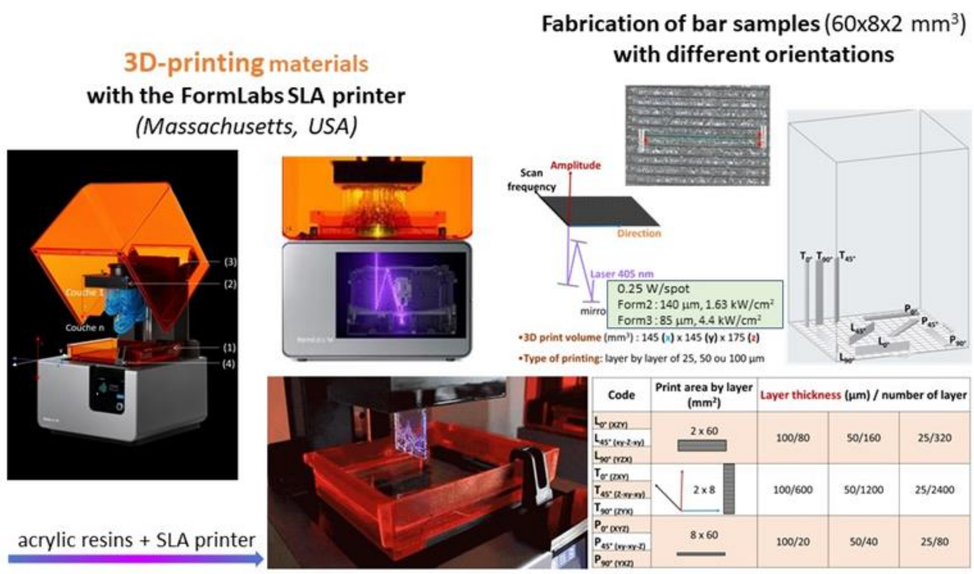
We have recently started exploring the potentialities of high energy radiation processing to consolidation of polymeric objects patterned in the 3 dimensions by techniques such as stereolithography. 3D printing of polymer materials by photopolymerization under UV-visible radiation (SLA) is based on the successive writing of lines or planar layers with uneven cohesion between the printed domains, within printed planes and between neighboring planes.

In the SLA laser printing method, 3D structures are manufactured, using different printing parameters allowed by the build platform: orientation (growth axis L-Longitudinal, T-Transverse, P-Plane and angle in the printing plane 0 - 45 - 90°) or layer thickness (25, 50 or 100 µm). Controlled exposure of polymer-based 3D patterns to high energy radiation can result in changes in crosslink density and glass transition temperature (Tg) due to post-curing and/or chain scission.



We will report here on the EB-induced post-modification of 3D objects printed by SLA using (meth)acrylate-based resins, with a focus on the changes in monomer conversion, thermophysical characteristics and tensile properties that occur upon application of increasing doses (up to 100 kGy). The strong influence effect of printing orientation with respect to the long axis of the printed specimens was evidenced. The thickness of the printed layers was also shown to impact the properties of the specimens before irradiation and their evolution after the EB post-treatment. On-going experiments reveal strong differences in resistance to stress propagation depending on the orientation and significant improvement of fracture toughness of 3D-printed specimens by EB irradiation at a dose of 10 kGy.