3D-PRINTING UNDER HIGH PRESSURE

Prof. Dr.-Ing. Jens Schuster

Institute for Polymer Technology West-Palatinate - Institut für Kunststofftechnik Westpfalz (IKW),
Department for Applied Logistics and Polymer Sciences, University of Applied Sciences Kaiserslautern.

Abstract

This study investigates effect of high ambient pressure and temperature on mechanical consolidation properties of filaments during the FDM-process. To achieve high strength properties as of injection molded specimens, a setup has made which consists of a 3D printer integrated into a customized autoclave. The autoclave has a capacity to maintain 135 bar of pressure. The void content between the filaments is significantly reduced. The pressure inside the autoclave provokes a more intimate contact between the contacting surfaces and result in higher mechanical properties such as yield strength and Young´s modulus.

So far, 3D-printing with PLA was carried out at 0 bar, 5 bar, and 10 bar additional pressure. Tensile, flexural, and Charpy tests were conducted on printed specimens, and the effect of pressure and temperature on 3D-printed samples were analyzed. It could be shown that autoclave preheating before printing and autoclave pressure during printing, improves the consolidation of layers immensely. The pressure inside the autoclave provokes a more intimate contact between the layer surfaces and results in higher mechanical properties such as yield strength, Young's modulus, and impact strength. The Youngs´s modulus in the critical transverse direction to the printing path could raised by a factor of 2.48 (Fig. 1). The yield strength was doubled in this direction. The properties in printing direction were improved by 30 %.

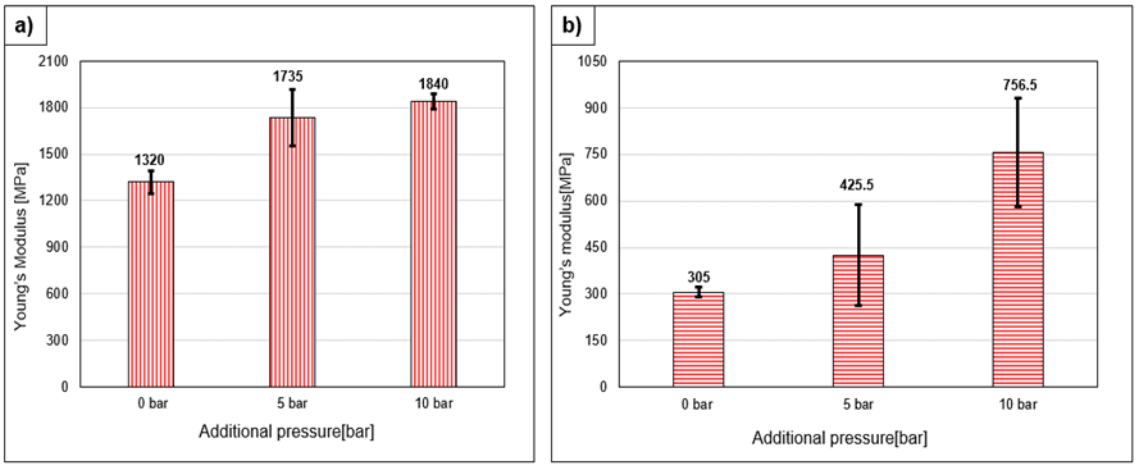

Fig. 1: Young´s modulus comparison of samples printed in different pressure conditions longitudinal (a) and transverse (b) to the printing direction