Optimization of FDM 3D printing of PLA polymers

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Abstract

Statement of the Problem: PLA polymers are intensively studied and used bio-based polyester. It is degradable in nontoxic carbon dioxide and water when composted. PLA polymers have similar mechanical properties to non-degradable thermoplastics, such as PET and polystyrene. The main processing technologies of PLA polymers are injection molding, thermoforming, 3D printing, spinning, blow molding, and foam molding. PLA polymers can be processed by equipment designed for the conventional plastics such as PE, PP, or PS.

Since, PLA has a low melting point, it is one of the most applied materials for 3D printing purposes. Among other methods, fused deposition modeling (FDM) 3D printing is the most used process in the 3D printing

Modern industry needs to manufacture PLA parts with more confidence. There are many processing systems and methods for 3D printing of PLA. Fused deposition modelling (FDM) is a common type of 3D printing processing. IT is very difficult to predict the optimal combination of FDM 3D printing process parameters/factors. This work was aimed to the understanding of the performance of 3D printing technologies, and to the understanding of application of fractional factorial design of the experiment in analysing the parameters/factors of FDM 3D printing processing of PLA.

It was accepted that influence of extrusion temperature, travel speed, printing speed, layer height, and working platform temperature were relevant parameters of FDM 3D printing of PLA. The optimization of parameters was calculated based on tensile strength. The factors of the FDM processing of PLA have been characterized by using fractional factorial experiment.

Conclusion & Significance: The study was approved out the relevance and influence of analysed process factors on tensile strength of FDM processed PLA polymers. Better results of tensile strength of 3D printed PLA polymers can be achieved by higher layer height, higher bed temperature, and lower extruder temperature.

Image

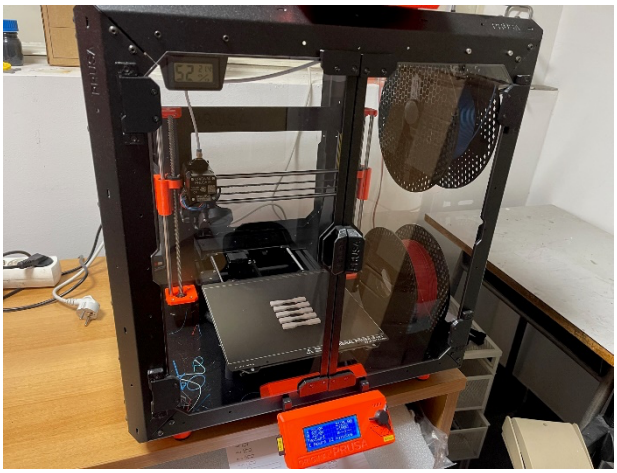

Figure 1.3D printing of PLA by printer Prusa i3MK3S

Recent Publications

1. Smoljan, Božo. Mechanical Metallurgy of Thermal Processing // Handbook of Thermal Process Modeling of Steels. Boca Raton: CRC Press, Taylor & Francis Group, 2009. p. 121-183
2. Smoljan, Božo. 2015 Quench Processing: Multiple // Encyclopedia of Iron, Steel, and Their Alloys /. New York: CRC Press, Taylor & Francis Group,. p. 2683-2705
3. Smoljan, Božo ; Smokvina Hanza, Sunčana ; Iljkić, Dario ; Hajdek, Krunoslav, An application of computer simulation of austenite decomposition in optimization of hot rolling of low alloyed steel bars // International Journal of Modern Manufacturing Technologies, XV (2023), 1; 34-43.
4. Smoljan, Božo ; Iljkić, Dario ; Smokvina Hanza, Sunčana ; Jokić, Milenko ; Štic, Lovro ; Borić, Andrej, Modeling and Computer Simulation of Steel Quenching // Materials performance and characterization, 8 (2019), 2; 17-36. doi: 10.1520/MPC20180040
5. Smoljan, Božo ; Hajdek, Krunoslav ; Šarkanj, Bojan ; Sitek, Wojciech, An overview of processing technologies, physical and mechanical properties of poly (lactic acid (PLA), and their applications // The 10th International Conference on Modern Manufacturing Technologies in Industrial Engineering / Nedelcu, Dumitru (ur.). Iași: Romania, 2022. str. 44-45

Photograph

Biography

Prof Božo Smoljan is Fellow of the International Federation for Heat Treatment and Surface Engineering (IFHTSE), London, for globally significant achievements in the field of modeling of thermal processes of material engineering, especially steel, as well as for the development of heat treatment and quenching of metals in general. He is awarded by State award for science of the Republic of Croatia in 2002 for creative work in the field of technical sciences; Annual award of the City of Rijeka for the year 2000, for creative work and achievements in 1998 and 1999, for a special scientific contribution in the field of production engineering, which is directly aimed at developing and improving industrial production; Award "Professor Fryderyk Staub Golden Owl" for achievements in promoting Polish science and higher education in the international arena and for achievements in collaboration with the Polish scientific community of materials engineering, AMME, Poland, year 2003; Recognition Octavian Pruteanu award for a contribution to the development of modern technologies, Professional Association in Modern Manufacturing Technologies, ModTech, Iasi-Romania, 2023.

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