Nanostructured materials | Jožef Stefan Institute Ljubljana, Slovenia

SEMINAR III

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Ceramic Additive Manufacturing By Micron Sized Droplet Jetting Of Thermoplastic Feedstocks

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Thermoplastic 3D printing (T3DP) is a material-jetting additive manufacturing (AM) process that uses thermoplastic feedstocks composed of paraffin-wax-based suspensions with high ceramic solid loading. During T3DP, the highly viscous suspension, which is kept at temperatures above the melting point of paraffin, is jetted through a nozzle with the help of mechanical movement of a tappet and applied pressure, forming an airborne micron-sized droplet of high kinetic energy. Once landed on the print bed, the droplet spreads under impact (kinetic-to-potential energy), and then recedes under the effect of surface tension. Individual droplets fuse to create lines and layers, necessary for manufacturing 3D geometries.

The aim of the work was to study the effect of particle interactions on the rheological properties of ceramic suspensions suitable for T3DP. For this purpose, we prepared wax-based, non-Newtonian suspensions with 40 vol% of zirconia (3Y-TZP), sterically stabilized by varying combinations of surfactants with different chain lengths; stearic acid (2.4 nm) and Solsperse 3000® (10 nm) to investigate the attractive and repulsive colloidal particle interactions, to understand the effect of steric barrier thickness and configuration on the rheological properties (differences in degree of flocculation) and droplet jetting dynamics. This was followed by analysis of the effect of different infill strategies (positioning of droplets and lines inside the part) on the mechanical properties of sintered bending bars. It was shown, that the type of flaw populations, final sintered density, flexural strength, and Weibull modulus were not as sensitive to the changes in infill strategy as it was observed for other extrusion-based AM strategies. By exploiting the suspension properties and process parameters, the current state of art for T3DP was improved.

Kindly invited.