NEMATX

Optimizing the material composition of liquid crystal polymers to enhance the interlayer adhesion during 3D printing

Master Thesis/Project

Goal

This project aims at optimizing the mechanical behaviour of 3D printed LCP parts in all dimensions by investigating custom material compositions based on LCP. By tailoring the material formulation towards increased interlayer adhesion, we wish to overcome the main problem in 3D printed parts - low mechanical properties in z direction - and obtain an enhanced high-performance material for 3D printing.

Keywords: 3D printing, material formulation, interlayer adhesion,high performance polymer

Description

High-performance lightweight structures are typically produced from fibre reinforced composite materials. However, they are energy- and labour-intensive to produce and are typically limited to simple geometries and reinforcement patterns. Far more complex parts with more sophisticated reinforcement patterns can nowadays be produced using 3D printing techniques. Recently it has been shown that it is possible to align thermotropic liquid crystal polymers (LCPs) during FDM printing and obtain complex parts with load adapted microstructures that show unprecedented mechanical properties rivalling fibre reinforced composites [1]. Thanks to the high degree of molecular alignment, the mechanical properties in the printing direction are 10 times higher when compared to top engineering materials for 3D printing like PEEK. However, the anisotropy given by the molecular alignment and by the intrinsic nature of the 3D printing process results in poor interlayer adhesion, which prevents the production of tall and lean parts. As interlayer adhesion is a common problem in 3D printed parts, various strategies have been developed for commercial 3D printed materials.

Approach

- Extrusion of filaments made from different material compositions.
- Study the effect of different formulations on the overall thermal and mechanical properties of printed samples, with focus on interlayer adhesion.
- Production of a “case study” part that benefits from the improved properties.

NematX

NEMATX AG is a spin-off from ETH Zurich, born in 2020. We are a young and dynamic team of 4 and our aim is to introduce the next generation in high-performance polymer 3D printing. Our “Nematic 3D Printing” technology allows for the production end-use parts which clearly outperform current benchmarks in polymer 3D printing. Target industries of include Aerospace & Space, Medical, Electronics and Industrial Applications where parts are exposed to harsh environments.

Contact

If you are interested in doing a project or thesis with us, please don’t hesitate to contact Chiara Mascolo (chiara.mascolo@nematx.com).

References

1. Gantenbein, S., et al., Three-dimensional printing of hierarchical liquid-crystal-polymer structures. Nature, 2018. 561(7722): p. 226-230.