ASSESSMENT OF REACTIVE THERMOPLASTIC COMPOSITE PULTRUSION FOR CONTINUOUS-FIBRE REINFORCED 3D PRINTING

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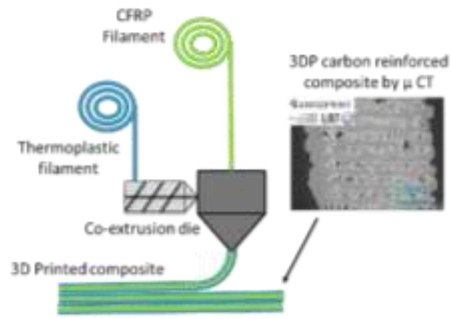

Figure 1 – CFRP 3D printing concept by Anisoprint

One of the new trends in additive manufacturing is the 3D printing of continuous fibre composite parts. Performance of such materials are significantly higher than for the typical 3D printed polymer materials made by filament deposition modelling (FDM) and stereolithography methods. In the frame of the project SAMIA-3D funded by the Luxembourg National Research Fund (FNR), LIST collaborates with Anisoprint to further develop its patented continuous-fibre 3D printing technology. The technology is based on a filament deposition process and involves multiphasic material. Materials currently used for the CFRP filament and the co-extruded matrix ensure the cost-effective production by printing of high performance composite material. Resulting properties present interesting mechanical properties compare to competitors and satisfy consumer's goods requirement. But the main limitation of the current setup for structural applications is the high void volume content of the printed parts, voids both induced by the filament manufacturing process and thus the overall quality of the filament itself and also by the 3D printing process because of hot formability and multi-material adhesion issues. One of our approach in the project is based on the improvement of the CFRP filament quality that can be achieved by using a reactive thermoplastic matrix for the filament manufacturing. The resin Elium® 595 supplied by Arkema exhibits interesting properties in terms of processability and also good mechanical properties similar to thermoset. Its reactivity and thermo-physical properties will be characterized through DSC, TGA and DMA. The manufacturing of thin filaments as well as their printability will also be assessed. A pultrusion-like process will be explored to produce filament with an expected high fiber volume ratio up to 65% whose thermo-physical and mechanical properties will be presented. In addition, the structure of the material will be investigated using a multi-scale approach, from surface aspect ratio and surface chemistry up to material morphology using SEM and micro-CT. Less than 0.5% of porosities are obtained on the filament material. Finally, printability of the reactive thermoplastic-based filament will be experimentally evaluated. Process induced defects such as multi-material interface, cracks and porosities will be characterized. Compared to existing thermoset based solution, a significant cracks and voids reduction has been observed.

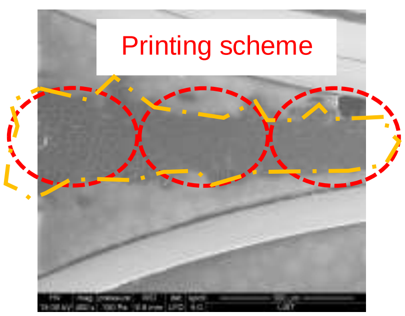

Figure 2 – SEM cross-sections of a CFRP Elium-based filament manufactured by pultrusion (on the left) and of a 3D-printed monolayer coupon made of 3 filaments (on the right)