Mechanical performance of bio-polyamide nanocomposites manufactured through FFF

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Additive manufacturing technologies allow creating 3D parts through layer overlap. For polymer-based materials Fused Filament Fabrication (FFF) has become the most common technology. However, it is currently difficult to predict the performance of the parts made by FFF, what limits their structural applications. This entails an important issue mainly due to the high anisotropy that layer deposition involves.

After having proving the viability of printing a nanoreinforced bio-based polyamide 11 through FFF [1] and having investigated the mechanical performance of the bio polyamides [2], in this work, a material model supported by a Finite Element Analysis tool has been developed. It attempts towards obtaining optimum parts regarding its mechanical performance with the reinforced polyamide.

The predictive model was fed by the results of a complete macro mechanical characterization carried out over printed specimens of Bio-PA11 nanocomposite at tensile, compressive and shear stress states. Experimental behaviour of the material turned out to be not only anisotropic, but also nonlinear and unsymmetrical. Apart from taking into account all these features, the model has been validated through bending tests to ensure its correlation with the experimental performance.

References

[1] M. Herrero, F. Peng, K. Núñez, J. C. Merino, B. Vogt, ACS Sustainable Chemistry and Engineering, 6 (2018)
[2] E. Rodríguez, L. M. Sánchez, E. Cañibano, J. C. Merino, XIII National Congress of Composite Materials (Vigo, 2019)

Figures

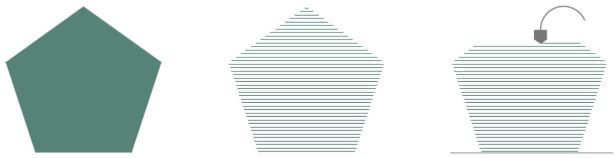

Figure 1: FFF part printing process including geometry definition, CAD slicing and material extrusion.

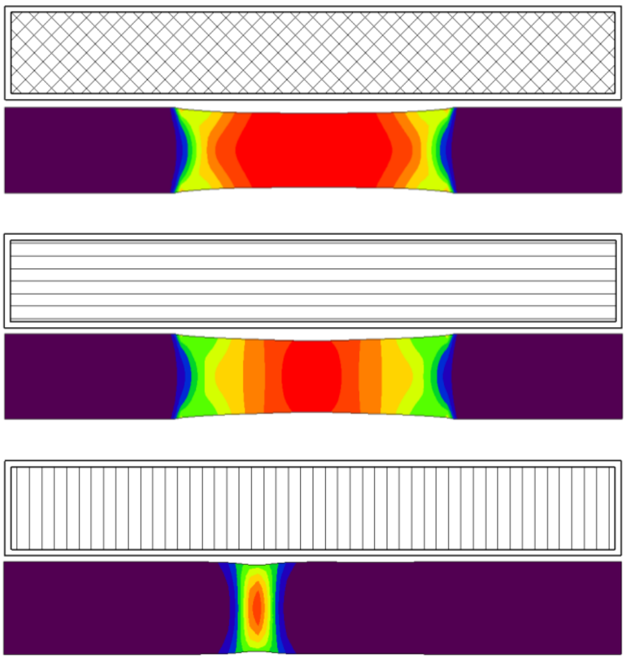

Figure 2: Strain contours obtained from tensile simulations on the three principal printing orientations (from top to bottom: flat, on-edge, upright) using the developed material model.