3D printing of liquid silicone rubber composites via a modified Direct Ink Writing (DIW) method

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Silicone rubber has widely been used because of its outstanding properties such as UV stability, excellent ageing properties, high chemical resistance, transparency, gas permeability, low compression set and stable mechanical properties over a wide temperature range, from -40 °C to 200 °C. However, silicone rubber manufacturing typically involves moulding processes, which limit the complexity of produced objects, as well as substantial human labour. For these reasons, additive manufacturing or 3D printing has attracted the attention of not only the scientific community [1][2] but also of the industry. In this work, we study the cure parameters of a liquid silicone rubber to be directly used in a non-commercial 3D printer via a modified Direct Ink Writing (DIW) method. Particularly, we have studied the curing kinetics, dispersions stability, and rheological properties of silicone composites to determine their effect on both printing process parameters and printed part properties. For instance, we founded that a volume flow dosing of 0,406 ml/min of the material was adequate for the printing process of a 5A type tensile specimen. We also determinate that the optimum printing temperature of the material was 70 ° C, since the sample retained the shape during the printing process and presented a good adhesion between the different layers. On the other hand, the kinetics of the silicone cross-linking process was determined by different techniques, finding activation energy of the order of 70-90 KJ/mol.

References

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[2] J. Herzberger, J. M. Sirrine, C. B. Williams, and T. E. Long, "Polymer Design for 3D Printing Elastomers: Recent Advances in Structure, Properties, and Printing," *Prog. Polym. Sci.*, vol. 97, p. 101144, 2019, doi: 10.1016/j.progpolymsci.2019.101144.

Figures

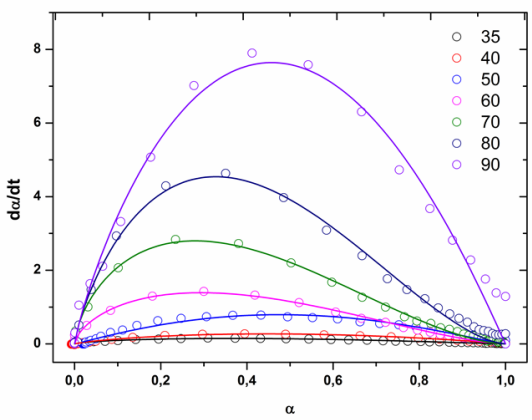

Figure 1: Rheological study on the cure kinetics of a two- part liquid silicone rubber.

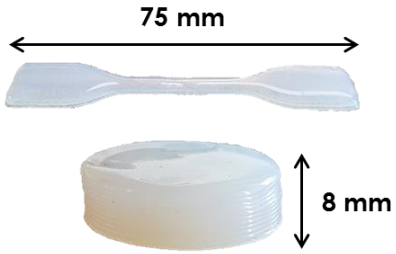

Figure 2: 3D printed samples using DIW additive manufacturing method.