Experimental determination and numerical simulation of material and damage behaviour of 3D printed polyamide 12 under dynamic loading

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ABSTRACT

The material and damage behaviour of additively manufactured polyamide 12 (PA12) under dynamic loading was characterized by cyclic tests and microstructure analysis. The results were used to develop a numerical material and damage model. In a recent study [1], it was shown that the material and damage behaviour of 3D printed PA12 under quasi-static loading is simulated in a realistic way by coupling the material model by Chaboche [2] and the damage model by Gurson-Tvergaard-Needleman (GTN) [3]. Using microscopy, X-ray refraction [4], and computed tomography, a porosity of about 5% was evaluated. These results served as a starting point for the present work. For the dynamic load, both the previously used Chaboche model and the GTN model were extended. Furthermore, the temperature was measured during the experiment and the self-heating effect was observed. Therefore, a temperature-dependent material parameters for the simulation were introduced. Considering the results of mechanical experiments, microstructural investigations, and self-heating effects, a good agreement between experiment and numerical simulation could be achieved.

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