Impact of sandwich lattice structures processed by selective laser melting

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Aluminum sandwich structures are commonly used in aeronautical and aerospatial applications. Essentially used in the wings or the fuselage, their interest resides in their high performance in term of ratio weight/mechanical properties. In this perspective, a constant objective is to improve the impact resistance of such sandwich structures while optimizing their weight. To achieve this, an option is to consider sandwich structures made of AlSi10Mg lattice structures produced by selective laser melting between Al2024-T4 plates.

The objective of this study is to determine how to maximize the absorbed energy and to understand the deformation mechanisms of the lattice structures measured experimentally after impact tests. The characterization involves mechanical testing and 3D X-ray tomography observations of the structures. Impact energies ranging from 5 to 30J are considered, with an unchanged stiffness of the sandwich structures, while the deformation increases. The behavior of such sandwich structures is strongly influenced by the material and geometrical properties of their core. Consequently, in order to determine the best choice to optimize the energy absorption and lightness of the structure, different building parameters are tested. Experiments studying the influence of the size (strut thickness, height of the cell,..) as well as the shape of the core unit cells are performed. Moreover, the material effect such as the presence or not of a post-fabrication heat treatment also affects the absorbed energy.

To further understand the behavior of the lattice structure under impact loading, a simplified model of the complex 3D geometry of the lattice is used, based on beam networks with co-rotational formulation to represent the core of the structures. The model is first compared with experiments on static compression tests. Impact test simulations are then performed using a full incremental-iterative strategy. It is shown that the simplified model correctly predicts the load-displacement response under impact loading, thereby paving the way to the use of simplified beam models for structural applications by means of model reduction techniques.