Experimental characterisation and parameter identification for yield surfaces of metal foams

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Metal foams are microheterogeneous materials, which offer a tripartite hierarchical structure. The macro scale comprises the entire component or specimen, the meso scale only deals with a couple of pores and the micro scale describes individual struts and their microstructure. Thus, the global macroscopic properties of foams are related to their behaviour on the meso scale as well as on the micro scale by a strong structure-property relationship.

The present contribution deals with the structural investigation of Al foams with different pore sizes by computer tomography data. The foams were analysed by their geometry and the mass distribution along the struts. Simulations on the micro scale outline the influence of geometrical changes.
Uniaxial and multiaxial experiments were performed on the macro scale to evaluate yield surfaces of the foams for each pore size. The results cover the most comprehensive experimental data set in the literature ever reported for open-cell metal foams. The yield surface strongly depend on the pore size and strut geometry. It varies between a symmetric ellipse and a kind of Drucker-Prager cap model. The yield surface according to Bier et al. consists of a log-log interpolation of an ellipse and an exponential function. Hence, it is able to cover the yield surface of the foams independently of the pore size. Therefore, this yield surface was implemented in FEAP® and used for parameter identification by inverse calculation. The different shapes of the yield surfaces were explained by the geometrical parameters deduced from the CT scans and impressively outline the structure-property relationship of foams.