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NUMERICAL ESTIMATION OF THE COMPRESSIVE STRENGTH OF CERAMIC OPEN-CELL FOAMS OF VARIABLE CELL SIZES

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Metal/ceramic interpenetrating composites are the materials obtained by liquid metal infiltration into a ceramic foam, which is produced by a chemical method of gelcasting. Porous ceramics fabricated by this method are characterized by a continuous network of spherical cells interconnected by circular windows. The open porosity due to the presence of windows creates good hydro-dynamical properties for liquid metals infiltration. For better understanding of the mechanical behaviour of these composites, a numerical model of a ceramic foam is needed, see e.g. [2]. In this work a numerical model of real foam with different cell sizes (porosities) is presented and its applications are discussed. Geometric characteristics of real foam samples were estimated from tomographic and scanning electron microscopy images. Using this information, numerical foam model was proposed. The example of real foam structure is shown in Fig. 1. A good agreement between numerical model and the results elaborated from microtomography was obtained.

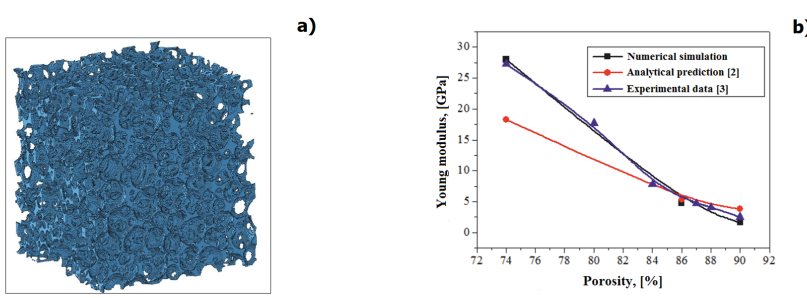

Figure 1: Fig. 1 (a) Example of the foam structure with 90% porosity; (b) The comparison of experimental data with numerical and analytical predictions.

To simulate the deformation processes the finite element program ABAQUS was used. The computer tompography made the basis for the formulation of computational model and finite element discretization, cf. [1]. Dimension of a finite element corresponds to the dimension of a single voxel and is equal to $16\mu m$. In all numerical calculations the cube-shaped sample of the foam with dimensions of 400x400x400 voxels was considered. Such assumption lead to a representative volume element (RVE) of the size 4x4x4 mm. The material of the skeleton of the ceramic foam was assumed to be isotropic and linearly elastic. Fig. 1a. presents, foam sample with 90% porosity under compression load. The bottom surface of the sample was fully constrained and the top surface of this sample was moved parallel to the vertical axis. The force was resulted from the final step of displacement in simulation. As a result of numerical simulation of compression test of alumina foam for different values of porosity, the Young modulus and the strength of such foams were estimated.

In Fig. 1b. the comparison of experimental data [4] with numerical and analytical predictions [3] of Young modulus for Al_2O_3 foams of different porosity is presented. It is visible that the analytical estimation shows a good correlation with the results of experiment and simulation for the range of porosity (84%-90%).

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