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Numerical simulation of dynamic processes in metal foams. I. virtual metallic foam

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The design of new multifunctional foams requires the solution of the following questions: in what way to fabricate metallic foams of assumed skeleton structure, how to produce *tomograms*, i.e. 3D virtual foam reconstructions of real foam structure [1], how to elaborate methods of numerical simulations of assumed processes in auxetic foams with use of the *tomograms*.

Depending on manufacturing method the cells obtain convex or concave shape. The materials with convex cell structure reveal positive value of Poisson's ratio, that is if a sample is stretching, then its cross-section is getting thinner. The complex structure of the foam related with reentrant cells produces the opposite effect during stretching of a sample, i.e. its cross-section is increasing. Then the negative Poisson's ratio is observed and such foams become auxetic.

The aim of the study is to study the third question. The motivation is given in [2], where it has been stressed that numerical simulations predicting a new material's behaviour reduce laboratory costs and accelerates the trial and error procedure. The subject of the study is metallic open-cell foam, in particular the foam of OFHC Cu skeleton. To simulate the deformation processes of such a material the finite element program ABAQUS is used. The virtual foam structure is derived from real foam specimen with use of computer tomography images implementing the procedures described in [3], [4]. The dimensions of a finite elements corresponds to the dimension of a single voxel and is equal to $2.52\ 10^{-6}$ *m*.

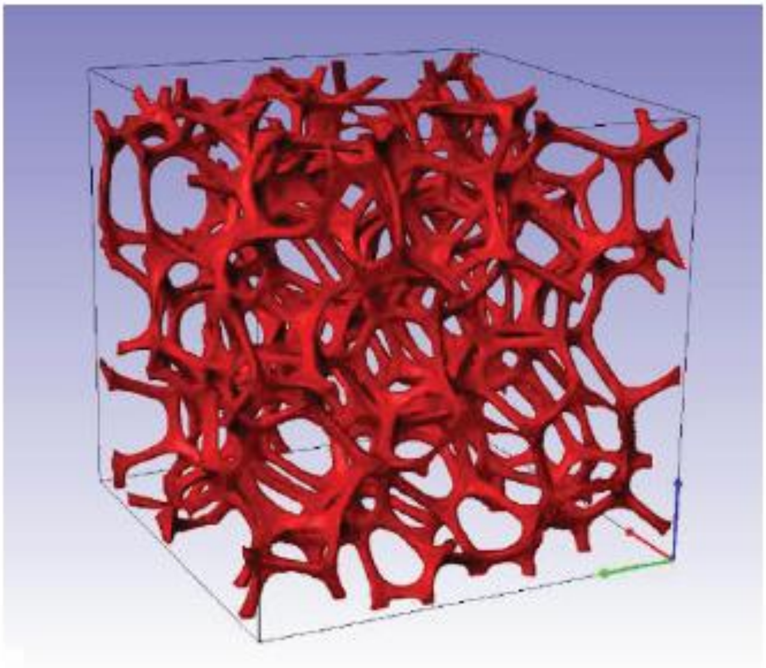

Fig. 1. The virtual skeleton of the convex open-cell Cu foam of 95% porosity within the cube of the edge of 800 voxels.

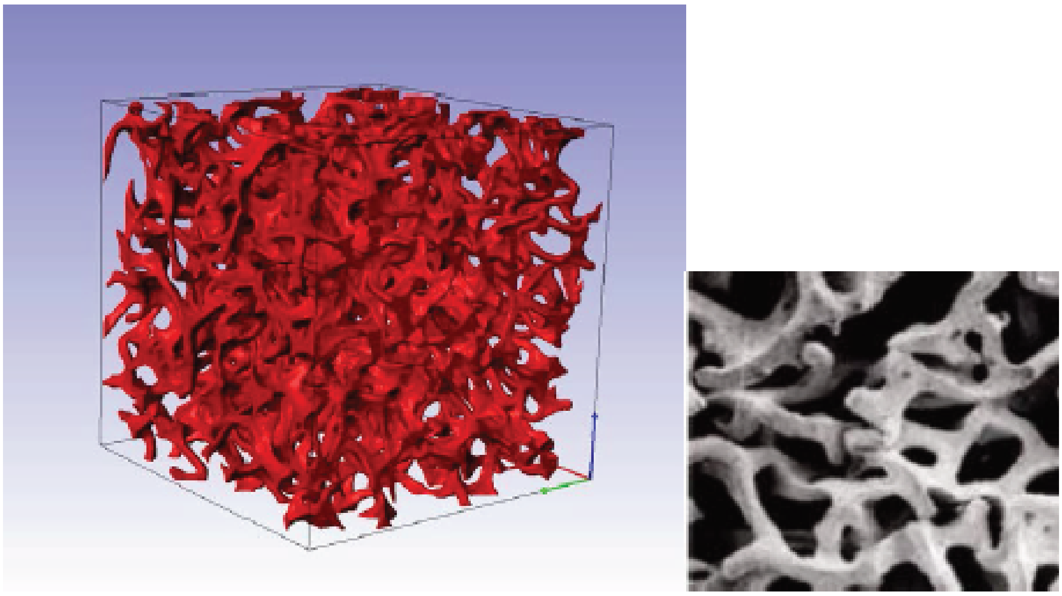

Fig. 2. The structure of the virtual auxetic foam with the estimated Poisson's ratio: - 0.3 in comparison with the picture of real Cu skeleton with reentrant cells obtained in [5].

The results of the above analysis can be applied for the prediction of manufacturing requirements. In Figure 2 an example of the structure of the virtual auxetic Cu foam resulting from numerical simulations is compared with the picture of Cu skeleton obtained experimentally by Lakes [6]. The both pictures reveal similarity of topology and geometry of the skeleton. The results presented in [6] show that the similar re-entrant skeleton structure can be obtained also for polyether foams.

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