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STRUCTURAL DEPENDENCY OF PERIODIC UNIT CELL MODELS ON MECHANICAL PROPERTIES OF ALUMINA FOAMS

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Recently, much attention has been attracted to interpenetrating phase composites (IPC) in which the open-cell foams are used as preforms [1]. Such composites are produced by infiltrating liquid metal into ceramic open-cell foams. The mechanical properties of final IPC are strongly depended on the structure of preform which construct topologically continuous network. Furthermore, the mechanical properties of the preform give the answer if it can be used in infiltration process. For example, too low compressive strength of alumina foam may cause damage of its struts during penetration by liquid metal. So, the determination of the mechanical properties of open-cell alumina foams and their structural dependency is of great interest. The aim of this work is to develop numerical models of unit

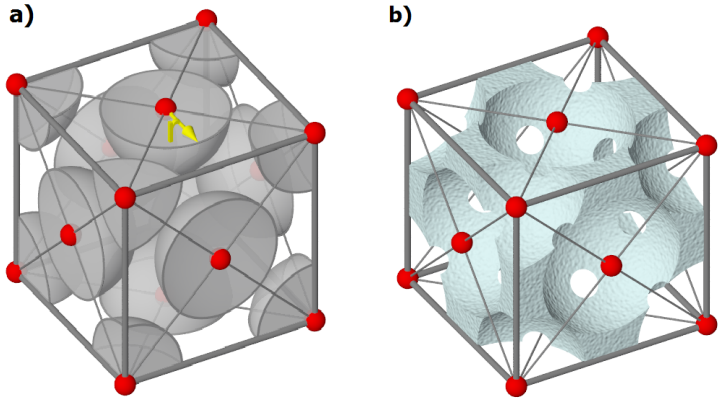

Figure 1: Arrangement of spherical bubbles in FCC crystallography system (a) and periodic unit cell model obtained by the subtraction of the bubbles from the unit box (b).

cell to predict mechanical properties of open-cell alumina foam with different porosities. The numerical parameters which are needed to build the unit cell model are based on

data obtained from microtomography images of real alumina foam. This foam is used as preforms in IPC [2]. Analyses of the microtomography images show that the alumina foams are composed of approximately spherical cells interconnected by circular windows [3]. Using these data the porosity, cell radius distribution, and window radius distribution of individual foam sample is computed and the geometry of unit cell is proposed. Fig. 1. shows unit cell model based on FCC crystallography structure of alumina foam with 90% porosity. Each of the bubbles has the same radius which corresponds to the mean value of distribution of cell radius. Similarly, the interconnection radius between two bubbles is equal to mean value of distribution of window radius. For calculations, the finite element method program ABAQUS [4] was used to estimate the mechanical properties such as Young's modulus, Poisson's ratio and compressive strength of alumina foam. To describe the brittle nature of dense alumina the constitutive model proposed in [5] was applied in numerical simulations. Several numerical analyses have been performed to investigate structural dependency of unit cell models on mechanical proprieties of alumina foam. Three unit cell models based on crystallography arrangement were considered: simple-cubic (SC), body-centered cubic (BCC) and face-centered cubic (FCC). The calculated results indicate that deformation and mechanical properties for FFC unit cell model are in good agreement with experiment.

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