Effect of grainnecking on properties of porous alumina

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Porous alumina has been investigated as support material for the ceramic permselective membranes. This porous structure design is essential for the separation membrane support to maximize the fluid permeability and minimizes the pressure drop of the permeating fluids by increasing pore volume as much as possible. Generally, fracture strength or thermal shock resistance of porous ceramics can be enhanced by decreasing the porosity or pore size. However, there is a fundamental trade-off between the mechanical properties and the permeation property, and the fluid permeability through the porous support decreases consistently with the decrease in the porosity or pore size. To apply porous alumina as a porous support for microporous ceramic membranes, it is important to establish a novel porous structure design concept to harmonize the simultaneous and sufficient fracture resistance and permeability of the porous alumina. We reported that increase of grain necking size without the decrease of pore volume was effective in enhance of these properties. In this research, a series of macroporous alumina with different pore size and porosity were fabricated by pulse electric current sintering method using different grain size of starting powders. To evaluate the effect of necking size on the properties, porous alumina with the larger necking size was sintered by increase of sintering temperature without grain growth. The permeability of the macroporous alumina was characterized by measuring nitrogen gas permeance, while the mechanical and thermal properties were evaluated by conventional and well-established methods. In order to estimate quantitatively grain necking size of porous alumina, the interfacial thermal resistance of grain boundary was evaluated by numerical method [1] using temperature dependence of thermal conductivity. The nitrogen permeability of porous alumina was slightly decreased with grain necking size. The fracture strength and thermal conductivity were increased with grain necking size. This research clarified quantitatively to the relation between properties of porous alumina and grain necking size.

[1]D. S. Smith et.al. J. Am. Ceram. Soc., 86 105-111 (2003).