which leads to well-oriented regions of grains and flat and elongated pores, whose long axes are parallel to the sheet plane. The increases in the size of the well-oriented regions and in the contact area between them break up pore connection, resulting in the formation of closed pores at a low density. Grain growth occurs above 1050°C and broadens the grain size distribution. 7 figs., 15 refs. [H. C.]

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Thermal Shock Resistance of ZrO_2 Ceramics Stabilized by Rare Earth Oxides Hiroshi WATANABE and Mitsuo CHIGASAKI, *Yogyo-Kyokai-Shi*, **94**, 330-35 (1986)——The thermal shock resistance of ZrO_2 stabilized by oxides of rare earth element (La, Nd, Ce, Sm, Gd, Dy, Er, and Yb) has been investigated. Among these ZrO_2 ceramics, only ZrO_2-Yb_2O_3 system shows an improved thermal shock resistance. Specifically ZrO_2-8 wt% Yb_2O_3 exhibits a superior thermal shock resistance to that of ZrO_2-7 wt% Y_2O_3 commonly used in the thermal barrier coating for jet engine components. Furthermore, the addition of 2 wt% Al_2O_3 to the ZrO_2-8 wt% Yb_2O_3 leads to a remarkable thermal shock resistance enhancement. In ZrO_2-8 wt% Yb_2O_3, the monoclinic ZrO_2 grains tended to coalesce into large clusters in the cubic ZrO_2 matrix. As a result, cracks are prone to initiate and propagate within the monoclinic phase during the martensitic transformation. On the other hand, the addition of Al_2O_3 results in the isolated spherical grains of monoclinic ZrO_2 phase, leading to an improved thermal shock resistance. 4 figs., 5 tables, 17 refs. [H. W.]

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Friction and Wear of Ceramics Measured by a Pin-on-Disk Tester Mikio IWASA and Yasuo TOIBANA*, *Yogyo-Kyokai-Shi*, **94**, 336-43 (1986)——Friction and wear properties of ceramics were measured by a pin-on-disk tester. Four of the most promising fine-ceramics, SiC, Si_3N_4, Al_2O_3 and PSZ were selected, and several samples of each with different raw powders, additives or sintering processes were used in this experiment.

SiC pins showed the lowest coefficient of friction and specific wear rate, followed by Al_2O_3 pins. As Si_3N_4 pins showed a relatively

higher coefficient of friction and specific wear rate, some improvement must be made for practical sliding part applications of Si_3N_4 ceramics. The coefficient of friction and specific wear rate of PSZ pins changed drastically according to disk materials, perhaps as an effect of their thermal conductivity. Wear of any ceramics pins except Al_2O_3 pins was lowest for sliding on SiC disk, followed by Si_3N_4, Al_2O_3 and then PSZ disk. 11 figs., 21 refs. [M. I.]

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Thermal Expansion of High Cordierite and Its Solid Solutions Hiroyuki IKAWA, Tadashi OTAGIRI*, Osamu IMAI*, Kazuyori URABE and Shigekazu UDAGAWA, *Yogyo-Kyokai-Shi*, 94, 344-50 (1986)——High cordierite ($Mg_2Al_4Si_5O_{18}$) and its solid solutions containing Fe, Mn, Ga or Ge were synthesized, and axial thermal expansions of those crystals were measured by means of high temperature X-ray powder diffraction.

The a-parameter increased while the c-parameter decreased with increasing substitution of Fe or Mn for Mg. The thermal expansion along the a-axis decreased whereas the negative expansion along the c-axis increased to positive side with increasing substitution.

The a- and c-parameters increased on the whole with increasing substitution of Ga for Al. The axial thermal expansion behaviours of Ga-bearing crystals with increasing amount of substitution were almost identical to those of Fe and Mn-bearing crystals.

The a- and c-parmameters increased linearly with increasing substitution of Ge for Si. The negative thermal expansion along the c-axis further decreased with increasing substitution, however, the expansion along the a-axis varied in a complex manner the amount of substitution. 10 figs., 2 tables, 29 refs. [H. I.]

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A Study on the Alumina Ceramics Casting Conditions by the Doctor-Blade Method and Their Effect on the Properties Green Type (Part 1) Kanji OTSUKA, Yoshiyuki OHSAWA* and Koichiro YAMADA**, *Yogyo-Kyokai-Shi*, 94, 351-59 (1986)——The thickness accuracy of the alumina ceramics green tape made by doctor-blade was improved. Calculation and experiment were