Selected Abstracts from *Yogyo-Kyokai-Shi*

As a service to readers and with the agreement of The Ceramic Society of Japan, selected English language Abstracts of the papers appearing in the *Journal of the Ceramic Society of Japan* (*Yogyo-Kyokai-Shi*) are reproduced here. The selection was made by Drs R. Stevens and P. Popper.

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Application of Plasma to Processing for Ceramics

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The thermal plasma processing for ceramics was surveyed with a stress on plasma spraying, plasma CVD and plasma sintering. The development of the low pressure plasma process and RF plasma process in plasma spraying is worth of special mention. These processes will be applied to ceramics coating in near future. Researches on thermal CVD are being carried out very actively for synthesis of high purity ultra fine ceramic powders such as silicon nitride and silicon carbide. This process has a very high potential as a means for rapid growth of ceramic films on various substrates. Low pressure RF inductive plasma and high power microwave plasma have characteristics quite different from RF glow discharge plasma. It is very interesting that these plasmas are applied to synthesize diamond and cubic boron nitride films. Rapid sintering of ceramic powders in plasma atmosphere is one of the most important applications of plasma to materials processing, but many problems remain to be solved in the sintering process. [*Received October 11, 1986*]

Structural Evolution of Sol-Gel Glasses

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This review examines the stages of the sol-gel process, including hydrolysis, condensation, gelation, aging, drying, and sintering. The species produced in the sol are polymeric, rather than being dense glass-like colloidal particles. Considerable control over the structure of the polymer is possible through an understanding of the chemistry of hydrolysis and condensation. The

properties of the gel and its response to heat treatment are sensitive to the structure created in the sol stage. Solvent must be removed slowly to prevent the high capillary stresses from causing cracking. A model of drying is presented that explains the relationship between cracking, drying rate, gel size, and permeability. Heat treatment causes densification of the solid phase, as well as collapse of the pores. The sintering behavior of gels is complex, because the viscosity of the gel is affected by concurrent structural relaxation and changes in hydroxyl content. [*Received October 14, 1986*]

Preparation of Composite Particles of SiC-Si_3N_4 System by Vapor Reaction Method

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The formation of SiC-Si_3N_4 composite particles by the vapor phase reaction of $Si(CH_3)_4$-NH_3-H_2 system at 1200°C was investigated with emphasis on the effect of mixing temperature of $Si(CH_3)_4$ and NH_3 streams. Powders produced were amorphous. When $Si(CH_3)_4$ was mixed with NH_3 in a low temperature zone below 900°C, the particle size was 0.05 to 0.07 μm and decreased with an increase in NH_3 concentration. When the mixing temperature was 1100°C, the particle size was nearly 0.02 μm regardless of NH_3 concentration. The amorphous powders crystallized into β-SiC and α-Si_3N_4 (partially including β-Si_3N_4) by the heat treatment at 1550°C in Ar-N_2 atmosphere. The crystallized phase from amorphous powder produced in low temperature mixing was SiC phase, SiC-Si_3N_4 composite and Si_3N_4 phase depending on the NH_3 concentration used, among which the composite particles had hybrid structure consisting of Si_3N_4 core and SiC shell. On the other hand, SiC-Si_3N_4 composite particles were obtained even at a high NH_3 concentration in high temperature mixing, and they consisted of SiC core and Si_3N_4 shell. The following formation processes of composite particles in the vapor phase reaction were proposed: in low temperature mixing (T_m = 700°-900°C), nitride particles were produced at first by the reaction between $Si(CH_3)_4$ and NH_3 immediately after the mixing and then carbide layer deposited on their surfaces from the unreacted $Si(CH_3)_4$, while in high temperature mixing (T_m = 1100°C), $Si(CH_3)_4$ polymerized and decomposed into SiC particles in a low temperature zone and then the SiC particles were nitrided with NH_3 in a high temperature zone.

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Synthesis of Ultrafine Si_3N_4 Powder by Plasma Process and Powder Characterization

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An ultrafine Si_3N_4 powder was synthesized by the vapor phase reaction of $SiCl_4$ and NH_3 in a thermal plasma arc jet. The as-prepared powder was white and amorphous, and had an average particle size of 30 to 40 nm. The production rate was 200 g/h. The heat treatment above 1380°C decreased the specific surface area and increased the crystallinity, implying that the grain growth and the crystallization occurred simultaneously. The oxygen content was reduced to 1 wt% at 1450°C. The powder thus obtained was the crystallized hexagonal grain with the average size 0.2 μm. X-ray diffraction indicated the presence of α-Si_3N_4 phase more than 95% and β phase as remainder. The sintering at 1700°C with the aid of 5 wt% Al_2O_3 and 5 wt% Y_2O_3 resulted in the relative density 98%, Vicker's hardness 16 GN/m² and the fracture toughness 7 MN/m$^{3/2}$.

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