Acireale, Sicily, Italy • June 4-9, **2006**



11th International Ceramics Congress
4th Forum on New Materials

CIMTEC 2006

INTERNATIONAL CONFERENCES ON MODERN MATERIALS & TECHNOLOGIES

ABSTRACTS

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due to better understanding of its chemistry. In this study, alpha-beta SiAlONs with varying amounts of SiC addition were designed and gas pressure sintered under 100 bar nitrogen pressure. Following standard characterisation procedures (XRD, SEM and mechanical properties), certain compositions were tested in turning of Inconel 718.

I-3: IL09 **Long-term Reliability of Structural Ceramics for High Temperature Applications**

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The prediction of lifetime of structural ceramics is often assumed to follow a model based on damage and crack growth. Pre-existing mechanical damage, usually in the form of a crack, is assumed to pre-exist in the ceramic. The time-to-failure is estimated as the time for the crack to grow from the initial to the final critical size for failure. All that is needed to estimate the time to failure is to characterize the crack growth and the initial crack size distribution in the ceramic. Unfortunately, other factors aside from crack growth often control the lifetime of ceramic materials, especially at high temperatures. If the structural ceramic is operating at a temperature at which creep can occur, lifetime depends on the generation of cracks by the creep process, rather than growth once the cracks are formed. Similar problems ensue if the ceramic is in a chemically reactive environment, so that pits are generated by chemical attack, or cross-section is lost as a consequence of chemical attack. In this paper, we discuss these high-temperature mechanisms of failure and propose a methodology for lifetime prediction in the case of failure by creep-rupture where cavity nucleation is the controlling factor for estimating lifetime.

I-3: SL10 **Reliability of Ceramics by Virtual Design and Testing**

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Ceramics offer a variety of properties that make them very attractive - sometimes even essential - for certain applications in automotive, e.g. piezoelectricity, electrical conductivity, robustness in harsh environment. However, insufficient reliability makes users skeptical and inhibits quite often a broad and successful market entry. To successfully overcome this weakness, reliability issues have to be tackled seriously from the very beginning of the development process. To do so, different aspects have to be taken into account and will be presented in this paper: - constitutive modeling of functional materials, - Finite element analyses of components function and (thermo)mechanical stressing, - Reliability and lifetime assessment in terms of failure probability, - Optimization and design rules for layout, - Materials characterization. The holistic approach will be demonstrated for a structural ceramic component and for functional components in extracts.

I-3: SL12 **Non Destructive Testing of Modern Ceramics**

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For quality control of structural ceramics destructive and non destructive methods are applied to assure important attributes of the product. In production process in most cases only optical methods as dye penetrant testing or acoustical signal analysis are used due to cost effectiveness. Many other non destructive methods can be applied during the development process of new products or for statistical quality control. This paper gives an overview of non-destructive methods for characterization of structural ceramics. It presents the application and limitation of acoustical methods as high frequency ultrasonics, optical methods as dye penetrant, thermographical and radiographical inspection. It shows the capability of three dimensional computed tomography for fast volumetric inspection, reverse engineering and rapid prototyping as well as atomic force microscopy in combination with ultrasonic excitation to characterize ceramics with submicron resolution.

Poster Presentations

Mechanical Behaviour

I-1: P02 **Strengthening of ZrO_2 Ceramics due to Nano-crystallization**

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Reducing grain size to the nanocrystalline range of <100nm is one of the promising ways for improving the mechanical properties of ceramics. Using high-energy ball-milling and spark-plasma-sintering (SPS) techniques, we can fabricate ZrO2-based ceramics with grain sizes of d = 90-350 nm. In this study, we will examine the effect of nano-crystallization on the mechanical properties of ZrO2 ceramics. The fracture strength σ of the ZrO2-based ceramics tends to increase with decreasing grain size. As compared with the data for submicrometer-sized material with d = 350 nm, nanocrystalline ZrO2 ceramics with d~90 nm can improve σ of the ZrO2-based ceramics by a factor of 2.0-2.5. The maximum strength reached ~ 2400 MPa, is classed as the highest for oxide ceramic materials. This can be associated to a decrease in the flaw size due to nano-crystallization and residual stresses induced by the SPS process.

Materials Processing

I-2: P06 **Sintering of Dense Silicon Nitride Ceramics at Low Temperature**

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An alternative methodology for highly dense silicon nitride ceramics sintered at a relatively low temperature is proposed. Silicon nitride ceramics with different sintering additives (amount and composition) were sintered in a high-temperature dilatometer up to 1750 °C. With these results, the temperature related to the maximum densification rate to each composition was established and applied as a new dwell sintering temperature. The new sintering profile allows to obtain ceramic bodies highly dense (>95% of the theoretical density) at temperatures significantly lower then the usually applied (~250 °C lower). Bodies were characterized for their microstructure, apparent density, and fracture toughness. The results indicate possible applications for the obtained ceramic; in addition the applied methodology should be explored with other ceramic systems.

I-2: P11 **Sintering of Silicon Carbide Ceramics with Additives Based on (Y_2O_3-Al_2O_3-SiO_2) System**

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Silicon carbide is one of the most important structural ceramics materials, which can be applied in abrasives, refractories, automotive engine components, cutting tools and many other applications. Sintering of silicon carbide can occurs in the presence of oxide additives, which forms a liquid phase at sintering temperatures. In this work, liquid phase sintering of silicon carbide based ceramics was investigated using different compositions based on (Y2O3-Al2O3-SiO2) system. 10 mol % of additives (in several compositions among them) were mixed with silicon carbide, dried and cold isostatically pressed. Samples were sintering in a graphite resistance furnace at 1950 °C/ 1 h. Final density and weight loss during sintering were estimated. Secondary crystalline phases were determined through x-ray diffraction. Microstructures of sintered materials were observed by scanning and transmission electron microscopy. Dilatometric experiments were useful to understand the liquid sintering process of silicon carbide, which is dependent on crystalline secondary transient phases that are formed and/or dissolved at different temperatures. The secondary phases identified during sintering change with composition, and have a significant influence on density and microstructure of sintered materials.