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Mechanism of spark plasma sintering of high temperature ceramics such as carbides (ZrC, B₄C)

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Spark Plasma Sintering (SPS) has proved its efficiency on the sintering of various materials which were known to be difficult to sinter without additives. In this presentation, the investigation of some thermomechanical properties will be illustrated on two different carbides: Zirconium carbide and boron carbide. Zirconium Carbide is interesting for high temperature application. Zirconium carbide (ZrC_x) and oxycarbide (ZrC_xO_y) carbide was synthesized by carbo-reduction of zirconia and carbon and was then sintered by SPS. A complete study including composition, particles size evolution was done. The kinetics of spark plasma sintered ceramics has been investigated. A change of densification mechanism appears during the intermediate and final sintering stages. During this last stage, the deformation mechanism is similar to the one involved during creep of dense ceramics. The comparison of densification and creep strain rates seems to show that no specific effects strongly enhance strain rate during the final densification stage of Spark Plasma Sintering. Boron carbide is a promising material for moderator in nuclear industry. The influence of preparation before SPS was studied: a liquid way was studied and compared. Different solvents were tested and green bodies were obtained. During this sintering, different chemical reactions were observed: oxides present in the native powder react and the composition of the carbide evolves. In a second step, thermomechanical properties were determined.

Biography

Alexandre Maître is professor at the Science of Ceramic Processes and Surface Treatments laboratory at Limoges in France. His thesis diploma (1995-1998) was devoted to the kinetic and thermodynamic aspects of the synthesis of transition metal carbides by carbothermal reduction. In October 2000, he obtained a permanent position as CNRS researcher at the Laboratory of Chemistry of Inorganic Solids at Nancy to develop investigations concerning the thermodynamic modelling, the electrochemical behaviour in corrosive environment, the metallurgical aspects of lead-based alloys. In September 2004, he became assistant professor in SPCTS to implement research activities about the elaboration by Polymer Derived Ceramics (PDCs) route and the mechanisms of sintering of high temperature ceramics. His scientific production (h index: 16) is now composed of 92 publications in international journals, 22 invited conferences, 65 oral communications, 3 chapters of books, 3 grants, etc. He was responsible for at least 15 national or international projects.

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