

Zirconia based composites with non-oxide additives

Jozef Vleugels

KU Leuven, Department of Materials Engineering, Kasteelpark Arenberg 44, B-3001
Leuven, Belgium

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Zirconia ceramics are amongst the strongest and toughest monolithic ceramics available, but they have a modest hardness and are electrical and thermal insulators. Transition metal carbides, nitrides and borides on the other hand are intrinsically very hard and electrically and thermally conductive, but suffer from a low toughness and strength. This presentation will focus on the development of ZrO₂-based composites with secondary phase additions (WC, TiN, TiCN, NbC, TiB₂, etc.) targeting a combination of high strength, toughness and hardness along with a minimum electrical conductivity allowing shaping by means of electrical discharge machining. Special attention is given towards the fine tuning of the transformability of the ZrO₂ matrix towards the secondary phase addition and the contributing toughening mechanisms in the composites. The influence of the non-oxide secondary phase additions on the slow crack growth resistance of electrically conductive zirconia-based composites is addressed. The advantages and disadvantages of hot pressing and pulsed electric current sintering are assessed, and the possibility of pressureless densification of ZrO₂-TiN composites with up to 40 vol% TiN is explored. Some potential applications of these ZrO₂-based composites are illustrated such as stamping and fine blanking tools for Cu-based alloys and steel, extrusion dies for Cu alloys and stainless steel, and tools for high speed turning of steel and drilling of grey cast iron.