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Abstract

Microstructural Modelling of the Thermoelastic Properties of Dense ZTA Ceramics †

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Alumina and zirconia materials have been used more and more in the fabrication of the so-called zirconia-toughened alumina (ZTA) technical ceramics and serve purposes, such as supports for catalysts and thermal or electrical insulators, among others. These applications require tight limits in terms of the ceramics' dimensions and properties, with a consequent high quality control by manufacturing companies.

Additive manufacturing (AM) appears to facilitate the accurate manufacturing of such components; however, the consequences of AM implementation in industrial systems, if not supported by fundamental research, can lead to consumption and resource increases, contrary to expectations. Therefore, the fine tuning of the manufacturing of components based on alumina (A), zirconia (Z), or a mixture of both (AZ) by additive manufacturing requires an analysis of the parameters that influence their final properties.

In this context, this work aims at the construction/definition of prediction models for effective thermoelastic properties of ZTA ceramics, considering the influence of the A/Z ratio at the microstructural (macroscopically homogeneous and isotropic material) level, using samples with different compositions of alumina-zirconia, obtained using slip casting and sintering at 1550 °C.

The thermoelastic properties of these slip-casted specimens, namely the Young's modulus, thermal conductivity, thermal expansion coefficient, and Poisson's ratio, were experimentally obtained for several alumina/zirconia ratios. These experimental values were analyzed together with microstructure patterns and were then compared with the numerical values obtained using finite element analyses. Both experimental and numerical results were compared with those predicted by micromechanics and composite theory models.

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