MICROSTRUCTURE AND PHYSICAL PROPERTIES OF THERMALLY SPRAYED MULLITE BARRIER COATINGS

Kaindl, R.[1], Angerer, P.[2], Lackner, J.M.[1], Wießner, M.[2,3] & Waldhauser, W.[1]

[1]JOANNEUM RESEARCH Forschungsgesellschaft mbH, MATERIALS – Institute for Surface Technologies and Photonics, Leobner Straße 94, 8712 Niklasdorf, Austria
[2]Materials Center Leoben Forschung GmbH, Roseggerstraße 12, 8700 Leoben, Austria
[3]Anton Paar GmbH, Anton Paar Straße 20, 8054 Graz, Austria
reinhard.kaindl@joanneum.at

Chemistry, structure and thermal diffusivity of thermally sprayed mullite coatings with a thickness of about 0.5 mm were investigated by scanning electron microscopy with energy-dispersive X-ray spectroscopy, ex- and in-situ X-ray diffraction from room temperature up to 800 °C and by laser flash method up to 600 °C. The bulk composition of the coating is close to the pristine powder and to stoichiometric 3/2- ($3Al_2O_3{\cdot}2SiO_2$) mullite. Individual splats are variable in their aluminum to silicon ratios and contain traces of calcium and iron. The XRD diffractogram of the as-deposited coating fitted best with a 3/2-mullite with the composition $Al_{4.9}Si_{1.1}O_{9.6}$ beside cubic γ-Al_2O_3 and a pronounced amorphous phase. In-situ high-temperature XRD analysis up to 800 °C showed the appearance of minor amounts of an unidentified crystalline phase at the highest temperature. The amorphous fraction displays almost no changes during the experiment. The thermally induced lattice expansion is around 2.6% for the lattice constants a and b and 7% for c, accompanied with a decreasing crystallite size from about 70 to 40 nm. The thermal conductivity λ of the coatings changes between 2.75 and 3.02 $W{\cdot}(m{\cdot}K)^{-1}$ in the temperature range 20 - 600 °C. This is significantly lower than for single crystal and dense mullite ceramics. Such extremely low values can be achieved by both increasing the porosity, number of microcracks and fraction of the amorphous phase and reducing the grain size and coating thickness.

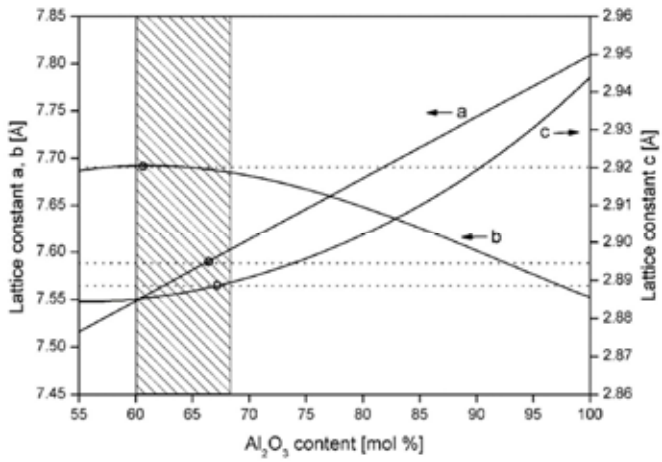

Figure 1. Lattice parameters of the compositional series $Al_2(Al_{2+2x}Si_{2-2x})O_{10x}$ versus Al_2O_3 content.