SYNTHESIS AND PHASE STABILITY OF THE ZRO_2-LN_2O_3-TA_2O_5 COMPOSITIONS FOR HIGH TETRAGONALITY ZIRCONIA-BASED THERMAL BARRIER COATINGS

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State-of-the-art TBC topcoat material is zirconia partially stabilized by 6-8% of yttria (ZY). The temperature limit for ZY coatings was determined to be 1200ºC on the basis of phase transitions and sintering properties. Rare-earth zirconates ($Ln_2Zr_2O_7$) with pyrochlore structure were found to be very promising for thermal barrier coating materials. They possess high thermal stability up to the melting point (around 2300ºC), low thermal conductivity (1.5 W/m·K at 1000ºC for bulk material) and low sintering rate, but their fracture toughness is very low.

On the other hand, a lot of experimental work was carried out on the search of alternative tetragonal zirconia stabilizers. Rare-earth oxides (neodymia, samaria, gadolinia, dysprosia, ytterbia, scandia and others) stabilized zirconia coatings were proved to have excellent mechanical properties combined with low thermal conductivity. It was found, that co-doped stabilized compositions offer better properties than ones with single stabilizer. Usually in the co-doped compositions the primary component is yttria and the secondary is rare-earth oxide, both components are stabilizers for zirconia. These compositions were shown to be effective in decreasing thermal conductivity, but their fracture toughness was decreased too. On that reason there is a trend on zirconia doping with destabilizing oxides to increase the tetragonality index and have low thermal conductivity at the same time.

The present paper focuses on the co-precipitation synthesis and properties of the yttrium ($YTaO_4$), neodymium ($NdTaO_4$), gadolinium ($GdTaO_4$) and dysprosium ($DyTaO_4$) tantalate powder and tantalate-stabilized zirconia powders ZrO_2-$YTaO_4$, ZrO_2-$NdTaO_4$. ZrO_2-$GdTaO_4$ or ZrO_2-$DyTaO_4$. Their phase composition was investigated at different calcination temperatures. Both yttrium and rare earth tantalates were shown to have two types of monoclinic structures (M and M’). As to zirconia-based compositions, both single and multi-phase samples were obtained depending on the tantalate amount and calcination temperature. Tetragonality indexes up to 1,027 were obtained.