Preparation of $(RE_{0.5}Yb_{0.5})_2Si_2O_7$ (RE=Sc, Er, or Yb) bulk ceramics and their corrosion behaviors by molten calcium-magnesium-aluminum-silicate at 1500 ℃

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Abstract: The demand for high operating temperatures in gas turbine engines requires an urgent need for environmental barrier coatings (EBCs) materials that exhibit excellent resistance to molten calcium-magnesium-aluminum-silicate (CMAS) glasses. In this study, three types of $(RE_{0.5}Yb_{0.5})_2Si_2O_7$ (RE=Sc, Er, or Yb) bulk ceramics were prepared using an in-situ solid-phase reaction method, and their CMAS corrosion behaviors were investigated at 1500 ℃. The results indicated that all the prepared bulk ceramics exhibited high densification and β-disilicate phase purity, and they showed both dissolution and penetration phenomena under CMAS corrosion at high temperatures. For $Yb_2Si_2O_7$ and $(Sc_{0.5}Yb_{0.5})_2Si_2O_7$ ceramics, no significant apatite phase was detected. However, a large amount of apatite phases was observed in the CMAS residual zone of $(Er_{0.5}Yb_{0.5})_2Si_2O_7$ ceramics. Furthermore, it is probable that $(Sc_{0.5}Yb_{0.5})_2Si_2O_7$ has the smallest average RE-O bond length, leading to the highest resistance to CMAS dissolution, which is approximately 4.6 times higher than that of $Yb_2Si_2O_7$, and 5.5 times higher than that of $(Er_{0.5}Yb_{0.5})_2Si_2O_7$. These findings may provide insights into the modification of CMAS corrosion resistance after doping of Sc or Er elements into the $Yb_2Si_2O_7$ matrix lattice, and lay the foundation for designing high-entropy EBCs with superior CMAS resistance.