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J Material Sci Eng 2017, 6:4(Suppl)
DOI: 10.4172/2169-0022-C1-071

3rd International Conference and Expo on

Ceramics and Composite Materials

June 26-27, 2017 Madrid, Spain

Magnetic properties in multi-layer ferrite thin films via spin-spray deposition

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The progress in the electronics industry demands a number of new soft magnetic materials for inductive components in electronics. Recent developments of ferrites can fulfill the special requirements of electromagnetic interference (EMI) and near field communication (NFC) applications. Here, we have developed well-ordered multi-layer thin films with Mn-Zn ferrite and Ni-Zn ferrite on PI substrates by the spin-spray deposition method. Structure analysis indicates that the crystal structure of multi-layer ferrite thin film is spinel structure, which also has a columnar structure normal to the surface. The multi-layer ferrite thin films exhibit high permeabilities that exceed the Snoek limit for bulk Mn-Zn ferrite and Ni-Zn ferrite. Multi-layer ferrite thin films have relatively high permeability μ' ~ 500 and μ" ~ 1 up to 50 MHz, and is promising to be used as thin film devices such as a magnetic applications. The spin-spray deposited Mn-Zn ferrite/Ni-Zn ferrite multi-layer heterostructures exhibiting high magnetic properties at both low and high frequencies provide great opportunities for fundamental studies and novel magnetic devices.

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Microwave synthesized pyrochlore zirconates plasma spray powders

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Pyrochlore-type rare earth zirconium oxide system ($Re_2Zr_2O_7$, Re=rare earths such as La, Gd and Yb etc.) are potential candidates for thermal barrier coatings (TBCs), high-permittivity dielectrics and solid electrolytes in high-temperature fuel cells etc. Some of its favorable characteristics to suit these applications are low thermal conductivity, high temperature phase stability (no phase transformation at high temperatures), low sintering rates at elevated temperatures and suitable coefficient of thermal expansion etc. For applications involving TBCs, the goal is to develop pyrochlore oxide based coatings which promise improved high temperature properties (>1200°C), much better than the currently popular Yttria Stabilized Zirconia (YSZ) TBCs. These TBCs are expected to allow increased gas turbine efficiencies that will protect the underlying metallic components from higher operating temperatures. This work is focused on preparing pyrochlore zirconates TBCs via microwave synthesis and evaluated for performance at high temperatures (1200°C–1500°C). Homogenous Pyrochlore zirconate compositions were synthesized via microwave sintering treatment of mixed and ground raw material powders at >15000C. Evaluated for phase composition such as stabilized zirconia or zirconates by employing X-Ray Diffractometry (XRD) the synthesized powders compacts were characterized for thermal conductivity that forms the primary criteria to serve as thermal barrier coatings (TBCs). Powders from selected few favorable compositions were further synthesized via spray drying to form plasma spray powders. TBCs prepared from the spray dried compositions were characterized for adhesion, thermal fatigue (shock cycling up to 1500°C and ambient), structural phase stability, interface and oxidation characteristics, microstructure, and suitability of service at high temperature without degradation in phase or spallation. Detailed oxidation stability characteristics study involved Electron Probe Micro Analysis (EPMA) across the coating-bond coat-substrate interface in metallographic cross-sections prepared from the TBC compositions which exhibited potentiality for long duration service under harsh environmental conditions. The coatings that have been prepared exhibited favorable characteristics to perform as TBCs superior to the conventionally prepared Yttria stabilized zirconia TBCs. The results and discussion pertaining to the superior TBCs are presented in this study.

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