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Reduction of thermal conductivity in $La_2Mo_2O_9$ by substitution of Bi dopant

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Introduction & Aim: To enhance the efficiency of engines, higher operating temperatures are required, which can be realized by using TBCs with lower thermal conductivity. $La_2Mo_2O_9$ is expected as one of a new candidate TBC material due to the quite low thermal conductivity, 0.95 Wm-1K-1 at 1273K. An adequate substitution is expected to reduce the thermal conductivity of $La_2Mo_2O_9$ by inducing additional phonon scattering. Here, we focus on lone pair electrons (LPEs) to further reduce thermal conductivity since a high degree of lattice anharmonicity under LPEs on the system cause to stronger phonon-phonon scattering, leading to ultralow thermal conductivity. The objective of present study is to further reduce the thermal conductivity of $La_2Mo_2O_9$ by substitution of element Bi^{3+} with LPEs at La^{3+} site.

Experimental Method: The $(La_{1-x}Bi_x)_2Mo_2O_9$ (x=0-0.2) powders were synthesized by solid-state reaction. The conditions of synthesis and sintering were 1173K for 12 hours and 1473K for 6 hours in air, respectively. The solubility limit and density were examined from X-ray diffraction patterns. The specific heat capacity and thermal diffusivity of $La_2Mo_2O_9$ were measured using differential scanning calorimetry and laser flash method in the temperature range from room temperature to 1073K, respectively. The thermal conductivity was calculated from the measured thermal diffusivity, heat capacity and density in the temperature range 300K-1073K.

Results & Conclusions: The maximum solubility of Bi^{3+} in $La_2Mo_2O_9$ was found to be x=0.15-0.20 and the relative density of specimens exceeded 88%. Almost temperature-independent thermal conductivities were observed for all the samples over the temperature range of the non-doped $La_2Mo_2O_9$. At room temperature, thermal conductivity decreases with increasing Bi dopant, lowered down to a value of 0.62 $Wm^{-1}K^{-1}$ when the Bi content was x=0.06. This value was 24% lower than that of the non-doped $La_2Mo_2O_9$. The underlying reason has been suggested that the lone pair electrons leads to stronger lattice anharmonicity.

Biography

Kyung Min Ok has his expertise in evaluation and passion in improving the functional ceramics. He works on the fabrication, characterization and analysis of functional ceramics, primarily materials with advanced thermal, electrical and mechanical performance. He uses a variety of thermal measurement and analysis tools to understand fundamental structure-processing-property relationships. His current research interests include extreme low thermal conductivity oxides and a correlation between thermal conductivity and elastic properties in oxides.

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