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Fabrication of $LaYO_3$ pellets for reaction-preventing material by sintering process

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1. Introduction

Fabrication of U-10Zr metallic fuels with rare-earth elements has been studied as a surrogate for pyro-processed fuels [1,2]. However, The REEs are difficult to separate from transuranic elements due to their strong chemical affinity and induce a technical issue like fuel loss caused due to reactions with casting parts during casting [2,3]. Y_2O_3 was used as a commercial coating material during casting, but even with its excellent thermal and phase stability, the fuel still reacted with the Y_2O_3-coated crucible [2].

To address this issue, $LaYO_3$ was introduced as a reaction-preventing material for casting of pyro-processed fuels. Previous study has confirmed the effectiveness of $LaYO_3$ in preventing reactions, but the fabrication process of $LaYO_3$ itself has not yet been studied [4]. Thus, this study investigated the phase formation and densification behavior to optimize the fabrication process for high-density $LaYO_3$ pellets.

2. Methods and Results

$LaYO_3$ pellets were fabricated by sintering process using La_2O_3 and Y_2O_3 mixture with a mole ratio of 1:1.3. Green compacts were fabricated by cold isostatic pressing. As shown in Fig. 1, sintering process was performed to investigate phase formation and densification behavior at various temperatures of 1633, 1703, 1743, 1763, 1773, 1793, and 1843 K.

Phase formation was identified using X-ray diffractometer (XRD). XRD analysis revealed that crystalline structures of $LaYO_3$ were formed in all cases. As shown in Fig. 2, two different structures of $LaYO_3$ were observed, with an orthorhombic perovskite structure observed at temperatures of 1633, 1703, 1743, 1763, 1773, and 1793 K and a monoclinic structure observed at temperature of 1843 K. The results indicate that the sintering temperature affects the resulting crystalline structure of $LaYO_3$.

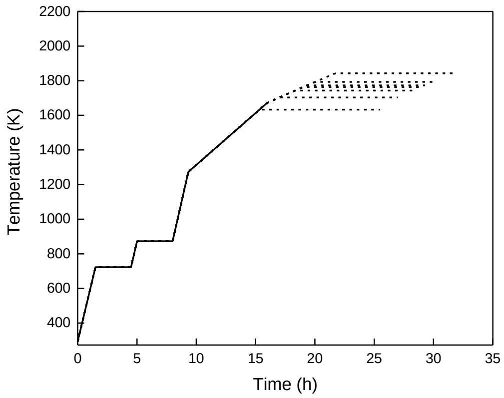

Fig. 1. Sintering profile for fabrication of $LaYO_3$ pellets

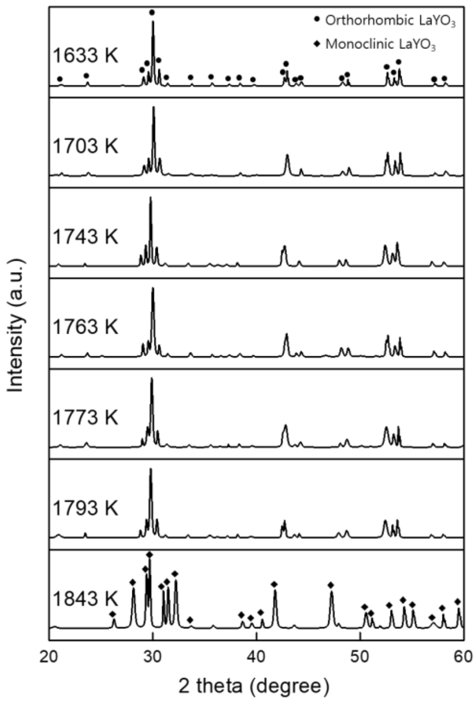

Fig. 2. XRD results of $LaYO_3$ pellets after sintering at temperatures of 1633, 1703, 1743, 1763, 1773, 1793, and 1843 K

Bulk densities of the pellets were investigated by the Archimedes method. As shown in Fig. 3, the bulk densities of the pellets increased up to 1763 K but the bulk densities of pellets decreased in spite of a further increase in sintering temperature. The bulk densities of orthorhombic-structured $LaYO_3$ and monoclinic-structured $LaYO_3$ were calculated to be 5.875 g/cm3 and 5.813 g/cm3, respectively. The calculations were performed with a mole ratio of 1:1.3 for La_2O_3 and Y_2O_3 using the lattice constants reported by H. Yamamura et al. for $LaYO_3$ [5]. It is speculated that the densification behavior of $LaYO_3$ pellets is correlated with phase transformation.

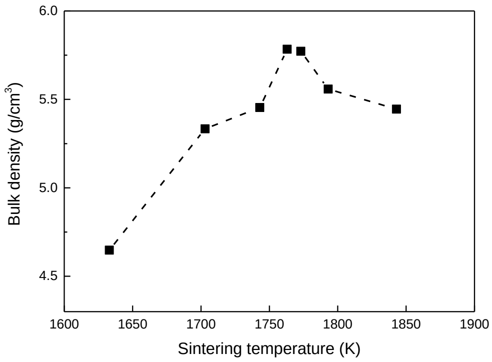

Fig. 3. Bulk densities of $LaYO_3$ pellets after sintering at temperatures of 1633, 1703, 1743, 1763, 1773, 1793, and 1843 K

3. Conclusions

Fabrication of $LaYO_3$ pellets as a reaction-preventing material was performed for casting of pyro-processed fuels. The highest bulk density of $LaYO_3$ pellets was achieved at a sintering temperature of 1763 K, even when heated at a higher temperature. The density of the sintered body usually increases with the sintering temperature and holding time, but the bulk density of $LaYO_3$ pellets was not temperature dependent. Therefore, further investigation is needed to understand the mechanism of densification behavior and what drives the process to achieve full densification.

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