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Effect of mechanical activation on solid-state synthesis process of neodymium disilicate ceramic pigment

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Abstract

The effect of mechanical activation of precursors ground in a high-energy density stirred bead mill on the synthesis of $\text{Nd}_2\text{Si}_2\text{O}_7$ powders was investigated. The reaction of precursors after the mechanical treatment at different milling time was analyzed by laser particles size analysis, thermogravimetry and differential thermal analysis (TG-DTA), X-ray diffraction (XRD) and scanning electron microscopy (SEM). The results reveal that the precursors without grinding and fired at 1200°C cannot form the $\text{Nd}_2\text{Si}_2\text{O}_7$ phase. $\text{Nd}_2\text{Si}_2\text{O}_7$ can be formed at 986.9°C when the precursors are ground for 3.0 h. To further clarify the effect of mechanical activation, two raw materials (i.e., SiO_2 and Nd_2O_3) were pre-treated by different methods. The raw materials mixed and subsequently ground is conducive to decreasing the temperature of forming pure $\text{Nd}_2\text{Si}_2\text{O}_7$ phase. The results indicate that the mechanical activation favors the promotion of the crystal growth of $\text{Nd}_2\text{Si}_2\text{O}_7$. In addition, the color properties of the synthesized $\text{Nd}_2\text{Si}_2\text{O}_7$ powders were also evaluated by reflection differential colorimetry. It is indicated that $\text{Nd}_2\text{Si}_2\text{O}_7$ powders that possess a high-temperature stability can be used as a ceramic pigment.

Keywords: Mechanical activation; Solid-state synthesis; Neodymium disilicate; Ceramic pigment

1. Introduction

Neodymium disilicate ($\text{Nd}_2\text{Si}_2\text{O}_7$) powder is considered as a potential functional pigment with “allochroic effect” under various illuminants, which could be a valuable ceramic pigment in the decoration [1]. The existing synthesis techniques for preparation of $\text{Nd}_2\text{Si}_2\text{O}_7$ powder are solid-state reaction [2-4] and some chemical solution-based methods such as co-precipitation reaction [5] and sol-gel method [1,6,7]. Although the chemical solution methods provide a

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