

# Role of luminescence in revealing sintering process of Cr<sup>4+</sup>:YAG transparent ceramics

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Since the first successful synthesis of transparent Nd:YAG ceramics described by Ikesue and co-workers in 1995, the development of transparent ceramic technology has significantly expanded the range of applications of lasers operating in both continuous-wave and pulsed modes. The most widely used active medium in solid-state lasers remains Nd:YAG, which accounts for more than half of the laser crystal market. A significant portion of this market consists of passively Q-switched lasers capable of operating in the so-called giant pulse generation mode.

A key component of these lasers is a phototropic material. Cr<sup>4+</sup>:YAG is currently the best material for passive Q-switching and is effectively replacing other alternatives, except for LiF crystals, which are expensive and have a short lifetime. Despite the importance of Cr<sup>4+</sup>:YAG ceramics, the number of available scientific publications on this topic remains limited, primarily due to challenges associated with the fabrication technology of transparent Cr<sup>4+</sup>:YAG ceramics.

One of the key elements in the technology of transparent YAG ceramics is the use of the sintering additive TEOS. Sintering transparent YAG ceramics without its use represents one of the most promising directions for further development of this technology. To date, only a few papers have reported on the sintering of transparent Nd:YAG ceramics without the use of TEOS. Obtaining high-quality transparent Cr<sup>4+</sup>:YAG ceramics requires the elimination of sintering additives such as TEOS, which itself constitutes a significant technological challenge. An additional difficulty is the need to introduce Ca<sup>2+</sup> and/or Mg<sup>2+</sup> ions to compensate for charge in the Cr<sup>4+</sup>:YAG structure.

The synthesis of Cr<sup>4+</sup>:YAG ceramics is associated with numerous challenges, and a full understanding of the sintering mechanisms requires the use of a wide range of research techniques. This presentation focuses on the role of luminescence in improving the sintering process of Cr<sup>4+</sup>:YAG ceramics and demonstrates how the analysis of dopant ion emission can provide insight into sintering mechanisms and contribute to improving the quality of laser materials, while also discussing the luminescent properties of Cr<sup>4+</sup> ions in the YAG structure.

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