Rare-earths doped Y_2O_3 laser materials

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Sesquioxide materials, such as Y_2O_3, Sc_2O_3, and Lu_2O_3, have been widely investigated as solid-state laser hosts due to their favorable properties, like stability, ruggedness, refractoriness, or optical clarity over a broad spectral region. In particular, Y_2O_3 has received great attention due to its high thermal conductivity [~13.5 W/(m·K)], good chemical stability, a broad range of transparency (0.2 μm to 8 μm), and relatively low phonon energy (~430 cm^{-1} to 550 cm^{-1}). However, the difficulty of growing large-size Y_2O_3 single crystals due to their high melting point of ~2430°C is well known [1-3]. Alternatively, ceramic technology allows obtaining high-quality Y_2O_3 transparent ceramics because the sintering process is carried out at a temperature much lower than its melting point. This technique can provide gain media for fiber lasers and also enable the manufacturing of composite laser media with complex structures that otherwise are difficult to fabricate. Recently, we have found that the use of multi-step sintering method performed in air followed by vacuum sintering could be an efficient technique to fabricate RE^{3+}-doped Y_2O_3 transparent ceramics having several technological advantages [2,3]. Typical $Nd:Y_2O_3$ and $Yb:Y_2O_3$ ceramics fabricated using this sintering technique are shown in Fig. 1.

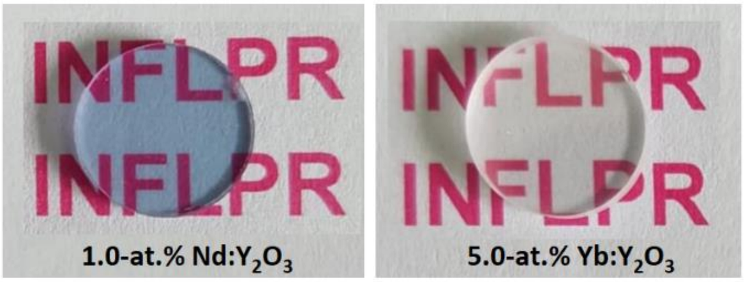

Fig. 1. Photos of the Nd^{3+}- and Yb^{3+}-doped Y_2O_3 transparent ceramics.

The phase identification revealed that all sintered ceramics are well crystallized and are similar to the standard cubic Y_2O_3 phase (Ia-3 space group), having no impurity phases. The microstructure presents a good homogeneity for all ceramic samples, with an average grain size of about 15 μm and no pores are observed at the grain boundaries or inside of the grains, concluding that the samples have a fully dense structure. High transmission up to 80% at the wavelength of 1.0 μm was recorded for all sintered ceramics. Laser emission at 1.0 μm was obtained under the pump with fiber-coupled diode lasers, and the results will be presented.

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References

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