Synthesis and characterization of Yb:CaF_2 transparent ceramics using an innovative energy-saving wet-route fabrication process

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Since the first Nd:YAG transparent ceramic for laser applications demonstrated [1] the many advantages of ceramics with respect to single crystals, rare-earth doped polycrystalline ceramics as a solid-state laser host material have experienced an increasing interest. In the past few years, our team has been focusing on a new class of transparent ceramics for near-IR solid-state lasers, Yb:CaF_2. This compound is very promising due to the combined properties of its fluoride matrix and the ytterbium ions.

We report here a new fabrication process for Yb:CaF_2 transparent ceramics [2] using a complete wet-route for the green body shaping and a strainless sintering of the ceramic. No post-treatment is used. The fabrication process is thus energy-saving.
Microstructural characterizations conducted on the obtained transparent ceramics show that the grain size is about 200 nm, and the grain boundaries appear to be thin, with no amorphous oxygen compounds[3].

The optical transmission of the obtained ceramics reaches more than 93% in the near-IR, which is better than the transmission of fluoride ceramics obtained with traditional dry-route fabrication processes.
The laser properties also prove to be improved [4] since the maximum power extracted from a 2.71 mm thick 4% at. Yb:CaF_2 transparent ceramic reaches 1.6 W (with a 6% coupler), which is the highest result recorded for powder-based Yb:CaF_2 ceramics.

References:

[1] A. Ikesue, T. Kinoshita, K. Kamata, and K. Yoshida, "Fabrication and Optical Properties of High-Performance Polycristalline NdYAG Ceramics for Solid-State Lasers," *J. Am. Ceram. Soc.*, vol. 78, no. 4, pp. 1033–1040, 1995.
[2] M. Mortier, P. Gredin, P. Aballea, and A. Suganuma, "Transparent metal fluoride ceramic," European patent application No. 14.305.495.5, 2014.
[3] J. Sarthou, P. Aballéa, G. Patriarche, H. Serier-Brault, A. Suganuma, P. Gredin, and M. Mortier, "Wet-Route Synthesis and Characterization of Yb:CaF2 Optical Ceramics," *J. Am. Ceram. Soc.*, DOI: 10.1111/jace.14216, 2016.
[4] P. Aballea, A. Suganuma, F. Druon, J. Hostalrich, P. Georges, P. Gredin, and M. Mortier, "Laser performance of diode-pumped Yb:CaF2 optical ceramics synthesized using an energy-efficient process," *Optica*, vol. 2, no. 4, pp. 288–291, 2015.