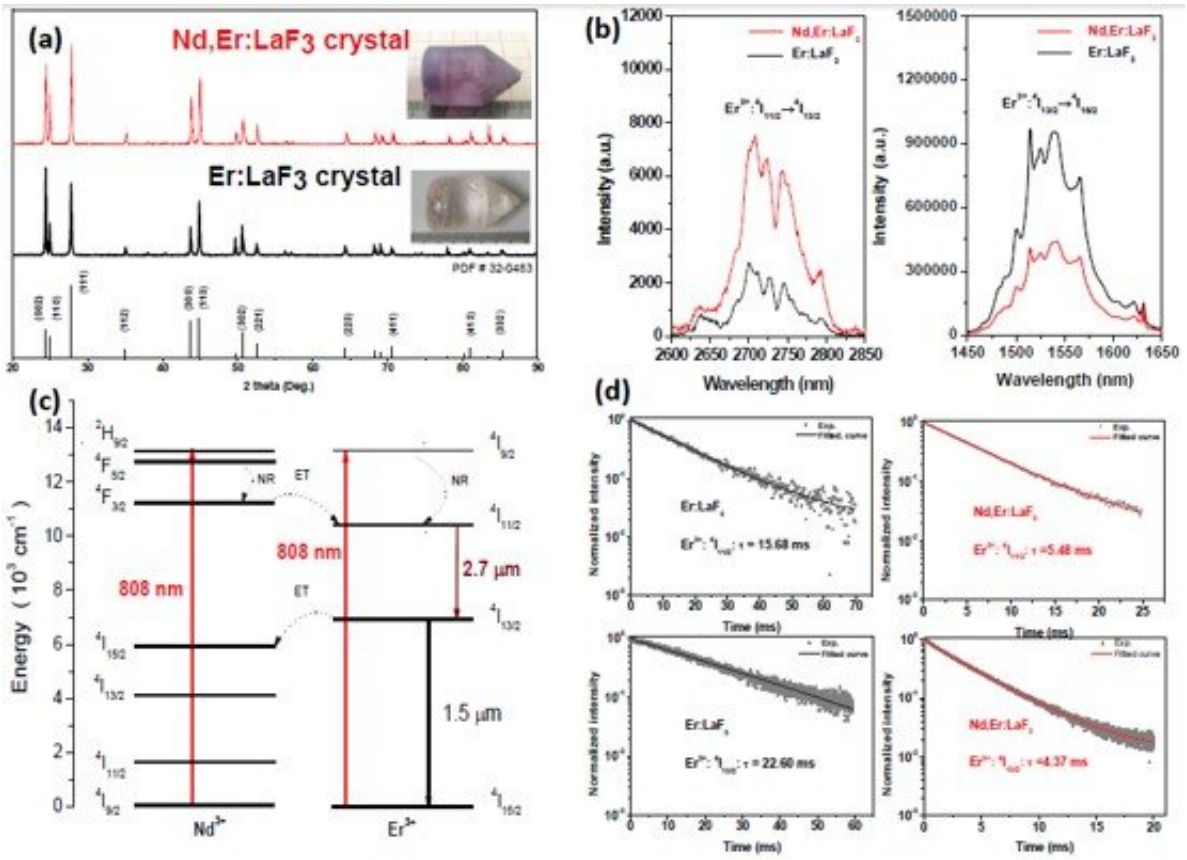
Novel laser crystal emerges as a promising candidate for 2.7 μm lasers

February 24 2020, by Zhang Nannan



Characterization of Nd,Er:LaF3 crystal. Credit: SIOM

In recent years, ~ 3 μm mid-infrared lasers have attracted much attention due to wide applications in biomedical treatments, molecular fingerprint identification and optical parametric oscillation (OPO) pumping source.

Generally, two methods are effective for the realization of mid-infrared laser. One method is a non-linear approach combined with OPO technique, which is structure-complicated and instable. The other one depends on pumping the mid-infrared laser crystal directly, which is more conducive to the development of the miniaturization and practicality.

Recently, a research team from Shanghai Institute of Optics and Fine Mechanics, Chinese Academic of Sciences, has succeeded in developing a new kind of low-phonon-energy laser crystal: Nd,Er:LaF_3.The crystal growth, structure, spectra, and self-termination effect were investigated. Their achievement was published in *Journal of Alloys and Compounds*.

In their experiment, for the first time, the Nd, Er:LaF_3 crystal was grown successfully by the Bridgman method. The Er:LaF_3 crystal was also grown for comparison. It remained hexagonal crystal structure free from a second phase. The segregation coefficients of Nd^{3+} and Er^{3+} were 0.96 and 0.76 respectively, indicating that it was easy to dope Nd^{3+} and Er^{3+} ions into LaF_3 host.

Furthermore, the intense 2.7 μm emission in Nd,Er:LaF_3 crystal was obtained under the 808 nm LD excitation. With the help of Judd-Ofelt theory and absorption spectra, the fluorescence branching ratio, emission cross-section and measured fluorescence lifetime at 2.7 μm were calculated to be 28.5%, 1.3×10^{-20} cm^2 and 5.48 ms, respectively.

Dual-function of Nd^{3+} ions were analyzed by comparing the mid-infrared fluorescence spectra with lifetimes of the upper and the lower energy levels in singly-doped and doubly-doped crystals.

They found that the Nd^{3+} ions not only sensitized the Er^{3+} ions but also deactivated the Er^{3+}:$4I_{13/2}$ energy level effectively by lowering the lifetime of the lower energy level from 22.60 ms to 4.37 ms with the

deactivation efficiency of 80.7% in Nd,Er:LaF_3 crystal.

It's worth noting that no self-termination effect exists in the Nd,Er:LaF_3 crystal. All the results show that Nd,Er:LaF_3 crystal is a promising candidate for 2.7 μm lasers pumped by a commercial 808 nm LD.

More information: Shanming Li et al. Nd^{3+} as effective sensitization and deactivation ions in Nd,Er:LaF_3 crystal for the 2.7 μm lasers, *Journal of Alloys and Compounds* (2020). DOI: 10.1016/j.jallcom.2020.154268

Provided by Chinese Academy of Sciences