Conclusions

In this work we have proved probed that large RTP:Nb single crystals can be doped with lanthanide ions in a concentration high enough to obtain laser action. The optical characterisation of the host and the active ions shows that a new self-frequency doubling crystal can be obtained.

We obtained the crystallisation regions of RTP in self-flux and in fluxes containing WO_3. We also obtained the changes that were introduced when Nb_2O_5 and Ln_2O_3 partially substituted TiO_2 in the self-flux. These changes, which depended significantly on the composition of the solution used, are produced by factors like the different ionic radii, the viscosity of the growth solution, the diffusion coefficient and the speed of growth.

Refining the crystalline structures of these crystals confirmed that Nb and Ln only go to Ti sites. While Nb^{5+} cations exclusively substitute Ti(1) sites, by an electrostatic effect rather than a steric one, Ln^{3+} ions substitute Ti atoms of $Ti(1)O_6$ and $Ti(2)O_6$ octahedra with the same probability. It is important to notice that the material was able to self-compensate electrically. In the characterisation of the structure with the temperature, substituting the (Ti^{4+}/Rb^{+}) pair with Nb^{5+} stabilised the high temperature cubic $RbTiPO_5$ phase and caused all the phase transitions in this structure to occur at lower temperatures as the concentration of Nb in the crystal increased.

The TSSG was devised to produce large single crystals of RTP, RTP:Nb, RTP:(Nb,Er) and RTP:(Nb,Yb) of optical quality using sufficient slow-cooling and an acentric crystal growth system that stirs the solution at the same time as it allows the crystal to growth. The concentrations of Er and Yb in these crystals were the highest ever obtained in a bulk crystal of the family of KTP.

Optical characterization of these crystals showed that this matrix is a good host for lanthanide ions, with useful laser applications in the near infrared and the green. Non-linear optical characterisation of these crystals showed that the SHG properties remained good, even when Ln^{3+} were included in the matrix.

Promising directions for future research can be oriented to study the possibility of designing periodically poled ferroelectric domains in these crystals, which makes them attractive non-linear crystals for use in quasi-phase-matching solid-state self-frequency doubling lasers and allows us to investigate new applications such as the self-optical parametric oscillators.

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