Yb:Er-doped LiLa(WO$_4$)$_2$ single crystal fiber growth

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Rare earth doped tungstate single crystals have early gained attention because of their suitable properties for laser media application. However, many of the tungstate compounds have a phase transitions, mainly the ones based on potassium ions (as KYW and KGdW) and they cannot be grown directly from their melt. The LiLa(WO$_4$)$_2$ compound is among the tungstate crystals that have a relatively low melting point (1065 °C), and no phase transitions upon cooling. Their growth, doped with rare earth ions, was reported by Czochralski and micro-pulling-down method. Single crystal fibers are attested as a low cost and reduced dimension alternative for laser devices [1] and an ideal method for crystallization studies. In this work, we investigate the growth process of Yb$^{3+}$/Er$^{3+}$:LiLa(WO$_4$)$_2$ single crystal fibers. The material’s synthesis and the effect of different dopant concentrations on the melting properties were studied by thermal analysis, x-ray diffraction and Rietveld analysis aiming to optimize the crystal growth. Fibers were characterized by x-rays diffraction and absorption and emission spectroscopy.

The starting materials LiLa(WO$_4$)$_2$ (LLW) and LiYb(WO$_4$)$_2$ (LYbW) were previously synthesized by the solid-state reaction method. The appropriate mixtures were weighted directly on the DTA crucibles for thermal analysis. Runs were performed under air atmosphere with heating/cooling rates of 5°C/min. Experimental X-ray powder diffraction patterns were measured at room temperature in the 10$^o$ to 100$^o$ range. The Rietveld method was used to analyze the obtained phases using the General Structure Analysis System (GSAS) program. Fibers were prepared in a resistive micro-pulling down furnace. The obtained DTA curves are in agreement with previous study of Li$_2$W$_2$O$_7$ – La$_2$W$_2$O$_9$ phase diagram for the compound LLW [2]. The addition of Yb modified the melting behavior of this compound as can be noted on Fig. (1a). LiLa$_{(1-x)}$Yb$_x$(WO$_4$)$_2$ fibers with 1 mm in diameter and 10mm long were prepared with fixed Er concentration (0.5 mol%) and variable Yb concentration (x = 1, 2, 5 and 10 mol%) (see Fig.1b). The observed results will be discussed.

![Fig. 1(a): DTA curves: (A) LLW; (B) LYbW and (C) 50%LLW:50%LYbW.](image1)

(A) LiLa(WO$_4$)$_2$
(B) LiYb(WO$_4$)$_2$
(C) 50%LLW:50%LYbW.

![Single crystal fiber of LiLa$_{(1-x)}$Yb$_x$(WO$_4$)$_2$ grown by micro pulling down method.](image2)


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