Structural, electrical and magnetic properties of Yb^{3+}-doped cadmium molybdato-tungstate single crystal

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Scheelite-type molybdate and tungstate crystals have the advantages of stable chemical properties, and they may be doped with a higher rare-earth ions concentration. From the spectroscopic point of view, Yb^{3+} ions exhibit several interesting features in comparison with other RE^{3+} ones. As active ions Yb^{3+} ions have only two manifolds, *i.e.* $^2F_{7/2}$ (ground state) and $^2F_{5/2}$ (excited state) which prevent laser losses owing excited-state absorption, up-conversion and concentration quenching encountered for Nd^{3+}-doped laser materials. Due to strong electron-phonon coupling, Yb^{3+} ions exhibit wider electronic transition lines and 3 or 4 times longer emission life-times in comparison with Nd^{3+} ions in similar hosts. For these reasons, Yb^{3+}-doped crystals allow a broad tunability of a laser oscillation and a generation of ultrashort laser pulses.

In this work single crystal of new Cd1-3xYb2x□x(MoO4)1-3x(WO4)3x (x = 0.0098, □ denotes vacancy) solid solution was successfully grown by the Czochralski method. X-ray diffraction measurement at 298(1) K showed that Yb^{3+}-doped single crystal adopts the tetragonal scheelite type structure with a space group $I4_1/a$. The Mo/W ions are tetrahedral coordinated and Cd/Yb – dodecahedral coordinated. The lattice parameters of the unit cell are: $a = b = 5.15539(12)$ and $c = 11.1919(3)$ Å and the agreement factor $R = 1.59$ %. Ytterbium ions do not show long-range order because we did not observe satellite reflections and they are randomly distributed in the unit cell, substituting the Cd^{2+} ones. Similar distribution of RE^{3+} was observed in other single crystals investigates by us, *i.e.* $Cd_{1-3x}RE_{2x}\square_xMoO_4$ (RE = Nd, Gd, Dy, and for different x values) [1-3].

The electrical conductivity $\sigma(T)$ and the *I-V* characteristics were measured with the aid of the DC method in the temperature range of 77–400 K using a KEITHLEY 6517B Electrometer/High Resistance Meter. The thermoelectric power $S(T)$ was measured in the temperature range of 300–600 K with the aid of a Seebeck Effect Measurement System (MMR Technologies, Inc., USA). The magnetic properties were designated in the zero-field cooled and field cooled mode using a Quantum Design Physical Properties Measurement System. The results of the electrical and magnetic measurements revealed semiconducting behaviour and ferrimagnetic long-range interactions below 2 K as well as antiferromagnetic short-range ones visible in the negative Curie–Weiss temperature (θ = -44 K). The magnetization of the single crystal under study at 2, 10, 20, 40 and 60 kOe is almost the universal Brillouin function of H/T, characteristic for superparamagnetic-like behaviour. A paramagnetic-diamagnetic transition at room temperature and at 6 kOe was observed.

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