Electron and hole trapping in Eu- or Eu,Hf-doped $LuPO_4$ and YPO_4 tracked by EPR and TSL spectroscopy.

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Streszczenie

EPR spectroscopy in X- and Q-bands was employed to trace charge carrier trapping upon exposure to X-rays of LuPO4:Eu, LuPO4:Eu,Hf and YPO4:Eu,Hf flux-grown single crystals, as well as LuPO4:Eu sintered ceramics. These data were complemented with thermoluminescence (TL) studies on the same compositions. EPR spectra proved that all the single crystals contained Pb impurity incorporated from the flux. Upon exposure to X-rays the concentration of Pb3+ changed proving that Pb participated in carrier trapping. The ionizing radiation caused also partial conversion of Eu3+ into Eu2+ and in the (Eu,Hf) doubly doped crystals also Hf4+ was transformed into Hf3+ upon exposure to X-rays. In the LuPO4:Eu sintered ceramics X-rays transformed Eu3+ into Eu2+ and the strong EPR signal of a hole trapped at O2− in the vicinity of a defect (presumably Lu3+-vacancy) was recorded. Some contribution from the PO42− molecular ion could also be observed. However, in crystals the EPR signal from the latter was much more intense compared to the former. In ceramics, the trapped hole was found to hop between the O2− ions and only below ∼70 K it localized at just one of them. Complementary measurements of TL of the samples showed meaningful differences between the glow curves of the crystals and of the ceramics. The TL glow curve of the latter contained only one band peaking around 120 °C which is related to destruction of the trapped hole being mainly the O− center. All single crystals showed multi-peak TL glow curves covering the range of 30–500 °C. They were found to result mainly from a hole released from the PO42− molecular complex and to some extent also from the O− center. The results relative to EPR and TL spectroscopy proved that in orthophosphates Eu3+ is an effective electron trapping center while holes may be trapped at impurity ions, like Pb2+, or localized at oxygen ions possibly stabilized by nearby defects, e.g. Lu-vacancies.