The effect of temperature and excitation energy of the high- and low-spin 4f→5d transitions on charging of traps in Lu_2O_3:Tb,M (M = Ti, Hf)

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Streszczenie

This work presents a fresh insight into the excited charges trapping in the Lu_2O_3:Tb,M (M= Ti, Hf) ceramics and their characteristics as storage and/or persistent luminescence phosphors. The results were obtained by applying an exceedingly versatile set of experiments based on thermoluminescence and thermoluminescence excitation spectroscopy and exposed a dual-nature of these materials. In the contrary to the previous research, here we found that at least some of these materials can generate efficient persistent luminescence due to the presence of shallow traps which can be charged only upon specific irradiation conditions – by the spin-forbidden 4f→5d transition of Tb^{3+} around 360 nm and, possibly, the $^7F_6 \rightarrow {}^5D_3$ intra-configurational transition of the activator at just slightly longer wavelengths. Besides that, changing the sample charging temperature the efficiency of filling the traps – both deep and shallow – with the 360 nm radiation varied greatly and exposed a very broad distribution of trap energies. Charging with 360 nm radiation at room temperature fills only the shallow traps giving, never reported in Lu_2O_3:Tb,Ti and Lu_2O_3:Tb,Hf, intense persistent luminescence, while at higher temperatures the deep traps are filled. At any temperature, radiation of wavelengths < 320 nm fills almost exclusively deep traps responsible for TL at high temperatures, 230 °C in Lu_2O_3:Tb,Hf and 355 °C in Lu_2O_3:Tb,Ti.

Słowa kluczowe

Luminescence, Defects, Thermally activated processes, Irradiation effect

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