Effect of Lutetium Co-Doping on the Main Dosimetric Peak of YAP:Mn\textsuperscript{2+} TL Detectors

Ya. Zhydachevskyy\textsuperscript{1,2}, M. Glowacki\textsuperscript{1}, N. Martynyuk\textsuperscript{2}, S. Ubizskii\textsuperscript{2}, M. Berkowski\textsuperscript{1},
A. Suchocki\textsuperscript{1,3}

\begin{itemize}
\item \textsuperscript{1} Institute of Physics, Polish Academy of Sciences, Warsaw, Poland
\item \textsuperscript{2} Lviv Polytechnic National University, Lviv, Ukraine
\item \textsuperscript{3} Institute of Physics, University of Bydgoszcz, Bydgoszcz, Poland
\end{itemize}

Application potential of Mn\textsuperscript{2+}-doped YAlO\textsubscript{3} (YAP) for thermoluminescent (TL) dosimetry of ionizing radiation has been shown previously (see [1] and references herein). For this purpose, one of two types of detectors can be used. The first type produces green emission near 530 nm (caused by Mn\textsuperscript{2+} ions) in the main TL peak at 200 °C, whereas the second type produces an orange emission around 640 nm in the TL peak near 350 °C.

Main features of the YAlO\textsubscript{3}:Mn\textsuperscript{2+} detectors are as following: high thermochemical and time stability, high resistance to radiation damage, high sensitivity to ionizing radiation (up to 40 relative to TLD-100 for \textsuperscript{60}Co), extremely wide range of linearity (from few µGy up to few kGy), high effective atomic number ($Z_{eff} = 31.4$) and consequently high energy response (about 40 for photon radiation of 55 keV/\textsuperscript{60}Co), low thermal fading of single crystalline detectors ($\leq$20%/year for 200 °C peak and $\leq$5%/year for 350 °C peak). In such a way the material is a good candidate for wide-range dose measurements, especially when tissue equivalence is not required, as well as for a purpose of the radiation quality determination if used alongside with other low-Z materials.

The TL peak at 200 °C is related most likely to Y\textsubscript{Al} antisites in YAlO\textsubscript{3} structure [2, 3], therefore it can be expected that substitution of yttrium ions by smaller lutetium ions can effect on this TL peak.

The Mn\textsuperscript{2+}-doped (Lu-Y)AP single crystals with Lu content of 0, 5, 10 and 20% (with respect to Y) were grown by the Czochralski technique as it was described before [2]. The studied crystals were characterized by photoluminescence and thermoluminescence techniques.

Mn\textsuperscript{2+} ions in (Lu-Y)AP crystals reveal the same as in YAP crystal the broad emission band with maximum at 530 nm (caused by the transition $^4T_1 (^4G) \rightarrow ^6A_1 (^6S)$ in Mn\textsuperscript{2+}). However the maximum of the TL peak at 200 °C was found to be shifted towards higher temperatures (from 200 °C for YAP:Mn to 230 °C for (Lu-Y)AP:Mn at 4 °C/s heating rate). Herewith this shift is not monotonous with increasing of Lu content. The TL peak shifts all at once for the crystals with the Lu content more than 5%. At the same time the position of the second TL peak near near 350 °C remains unchanged.

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