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Tunable red emission in Mn-doped MgO-TiO_2 solid solutions sintered by solid state reaction method

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Recently, Mn-doped titanates, showing intense narrow red emission, have attracted considerable interest due to their potential application as red-emitting phosphors in warm LEDs. Here we present the results of optical and structural investigations of the films of Mn-doped Mg titanates. The samples were produced through a traditional high temperature solid-state reaction method at 800-1150 °C using TiO_2, MgO and $MnSO_4$ powders as the raw materials. Some of the samples were additionally co-doped with Li (using $LiNO_3$) in order to get insight on the role of Li in the promotion of the crystal phase formation. Mn content in the samples was varied from 10^{17} to 10^{21} cm^{-3}.

The X-ray diffraction (XRD) shows that formation of Mg_2TiO_4 with a cubic structure sets in at 1050 °C and its concentration increases with the increase of the annealing temperature, while $MgTiO_3$ phase is present in all films studied. The XRD patterns of Li co-doped films proved that Li strongly promote crystal phase formation. In fact, the concentration of Mg_2TiO_4 was twice larger in the films sintered at 1050-1100 °C.

In the photoluminescence (PL) spectra, two sets of PL bands centered at 660 and 702 nm were observed. Both these components are ascribed to spin forbidden $^2Eg \rightarrow {}^4A_{2g}$ transition of the Mn^{4+} ions located in the Mg_2TiO_4 (the band at 660 nm) and $MgTiO_3$ (the band at 702 nm) crystal phases. The largest PL intensity was obtained for the films doped with [Mn]=10^{20} cm^{-3}. An enhancement of the PL intensity at least in 2.5 times was observed for Li co-doped films, showing the highest efficiency for the films sintered at 1100 °C. These results demonstrate the ways for tuning the red emission in Mn-doped titanates.