

# Novel persistent luminescence mechanism for the red-emitting $\text{Eu}^{3+}$ -doped rare earth oxysulfides

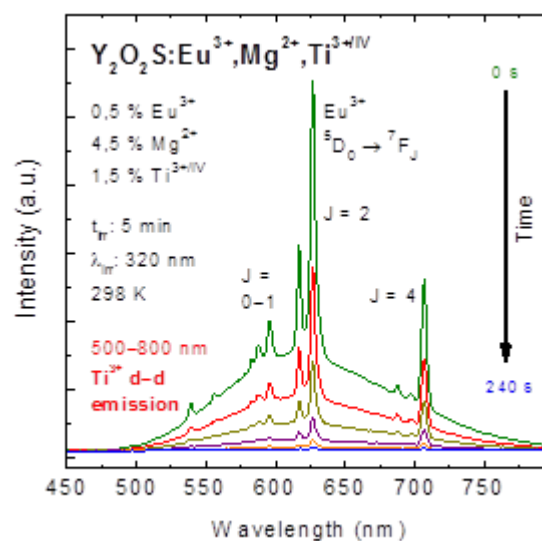
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Since the discovery of  $\text{Eu}^{2+}$ -activated long persistent luminescence materials, only a few red and near-infrared (NIR) persistent luminescence materials can be found in literature.<sup>1</sup> The  $\text{Y}_2\text{O}_2\text{S}:\text{Eu}^{3+},\text{Mg}^{2+},\text{Ti}^{3+/IV}$  is so-called one of the most efficient red persistent luminescence, nonetheless the persistent luminescence mechanisms proposed for this material are qualitative and sometimes inconsistent. In addition, the preparation of rare earth oxysulfides ( $\text{R}_2\text{O}_2\text{S}$ ,  $\text{R}^{3+}$ : La, Gd, Y) is difficult due to degradation  $\text{R}_2\text{O}_2\text{S} \rightarrow \text{R}_2\text{O}_3$  processes under high temperatures. In this work, the  $\text{R}_2\text{O}_2\text{S}:\text{Eu}^{3+}$  and  $\text{R}_2\text{O}_2\text{S}:\text{Eu}^{3+},\text{Mg}^{2+},\text{Ti}^{3+/IV}$  materials were successfully and rapidly (2 steps of 25 minutes) prepared by microwave-assisted solid-state synthesis (MASS). All materials presents red persistent luminescence arising from  $\text{Eu}^{3+}$   $^5\text{D}_0 \rightarrow ^7\text{F}_{0-4}$  emissions. Mg,Ti-co-doped materials also presents a broad emission band, which is related to the  $\text{Ti}^{3+}$   $d-d$  transitions (Fig. 1). The intensity of  $\text{Ti}^{3+}$   $d-d$  persistent emission is host  $\text{R}_2\text{O}_2\text{S}$  dependent:  $\text{La} < \text{Gd} < \text{Y}$ .

A new persistent luminescence mechanism is proposed including hole-trapping and electron-trapping processes. The hole-trapping mechanism occurs *via* valence band and it is related to the  $\text{Eu}^{3+}$  ions, explaining the persistent luminescence observed in non-co-doped materials. On the other hand, electron-trapping mechanism occurs *via* conduction band and it is responsible to the broad band  $\text{Ti}^{3+}$  persistent luminescence. The enhancement of  $\text{Eu}^{3+}$  persistent luminescence through Mg,Ti-co-doping is due to an energy transfer  $\text{Ti}^{3+} \rightarrow \text{Eu}^{3+}$  process, which is very efficient in the  $\text{Y}_2\text{O}_2\text{S}$  host, explaining the supremacy of the  $\text{Y}_2\text{O}_2\text{S}:\text{Eu}^{3+},\text{Mg}^{2+},\text{Ti}^{3+/IV}$  material. The unique energy transfer  $\text{Ti}^{3+} \rightarrow \text{Eu}^{3+}$  process established in this work opens a way on the systematic designing of new red, and also NIR persistent luminescence materials, suitable for bio-imaging probes and solar cells sensitizers.<sup>2</sup>



**Fig. 1** Persistent luminescence spectrum of the  $\text{Y}_2\text{O}_2\text{S}:\text{Eu}^{3+},\text{Mg}^{2+},\text{Ti}^{3+/IV}$  material.

Keywords: Persistent luminescence, Oxysulfide,  $\text{Eu}^{3+}$ , Mechanism, Microwave synthesis.

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## References

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