$LiGa_5O_8:Cr^{3+}$ as NIR Persistent Phosphor for In Vivo Imaging

O.Q. De Clercq*, P.F. Smet*, K. Braeckmans[#] and D. Poelman*

*Lumilab, Dept. Solid State Sciences, Ghent University, Ghent, Belgium;

[#]Bio-Photonic Imaging Group, Ghent University, Ghent, Belgium

Dirk.poelman@ugent.be

The use of infrared emitting persistent phosphors for medical imaging is an exciting application in the field of persistent luminescence [1]. Current research focuses on host materials doped with Mn^{2+} or Cr^{3+}, as these transition metals show emission at wavelengths larger than 600 nm, which falls in the tissue transparency window (Figure 1) [2]. In this work, we focus on Cr-doped $LiGa_5O_8$ (LGO), which is one of the most promising dopant-host combinations for near infrared emission [3].

LGO has an inverse spinel crystal structure, where half of the Ga^{3+} cations in the host occupy tetrahedral lattice sites and the other cations occupy octahedral sites. Owing to this inverse structure, LGO has a large amount of intrinsic defects, making the host highly suitable as persistent phosphor candidate. Cr dopants substitute for Ga in octahedral sites, leading to NIR emission from the $^4T_2$ and ^2E states, after excitation with UV or VIS light. Persistent luminescence is induced by UV excitation and lasts for about 20 min, before the afterglow intensity drops below 0.01 mW cm^{-2} sr^{-1}. Partial substitution of Ga in the lattice with Ge^{4+} cations induces additional lattice defects that enhance the persistent luminescence and increases the afterglow time of the Cr^{3+} emission.

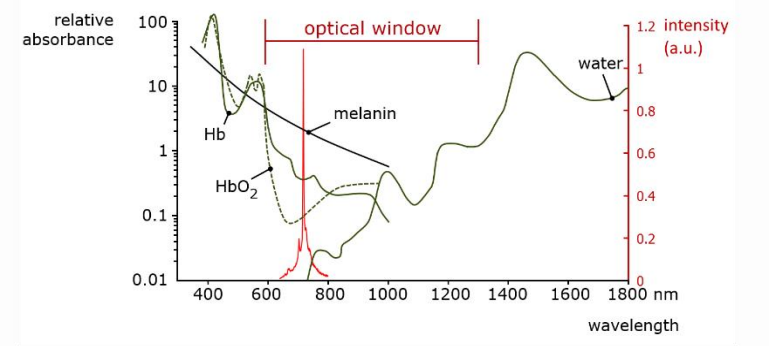

Figure 1: Relative absorbance curves of several components of blood (green). The absorption is minimal in the region 600-1300 nm, i.e. the optical window of tissue transparancy (Hb: hemoglobin; HbO_2: oxygenated hemoglobin). Also shown is a typical emission spectrum of $LiGa_5O_8$:Cr3+, peaking at 720 nm (red).

[1] Q. le Masne de Chermont et al., PNAS **104**, 9266 (2007).

[2] Y. Zhuang et al., Opt. Mater. **36**, 1907 (2014).

[3] F. Liu et al., Sci. Rep. **3**, 1554 (2013).