Luminescent Materials: The Devil is in the Defects

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Luminescent materials are at the heart of lighting, displays and imaging devices while new functionalities are explored for sensing, security and information technology, also driven by unique capabilities of nanocrystals. Optical properties are well-understood and rely on luminescent ions that absorb and emit light as required. At the same time, defects play a crucial role in the performance, limiting efficiency, stability and response but the nature and role of defects has remained elusive. In this presentation three topics will be addressed where the crucial role of defects and impurities will be discussed:

1) Strong variations in luminescence efficiency, spectra and afterglow induced by ppm levels of impurities and defects in micro- and nanocrystalline phosphors.[1,2,3,4]
2) Charge trapping and recombination processes in persistent luminescent materials.[5,6]
3) Ion diffusion in lanthanide-doped microcrystals and (core-shell) nanocrystals.[7,8]

Defect identification is difficult and only for a few systems clear evidence for the nature and role of defects has been obtained using a combination of techniques, including luminescence, EPR/ENDOR,[9] elemental analysis, thermally- and optically stimulated luminescence and, more recently, also taking advantage of atomic resolution electron microscopy.[10] Next to discussing the state-of-the-art an outlook will be given aimed to stimulate research into a better understanding of the role of defects in our field.

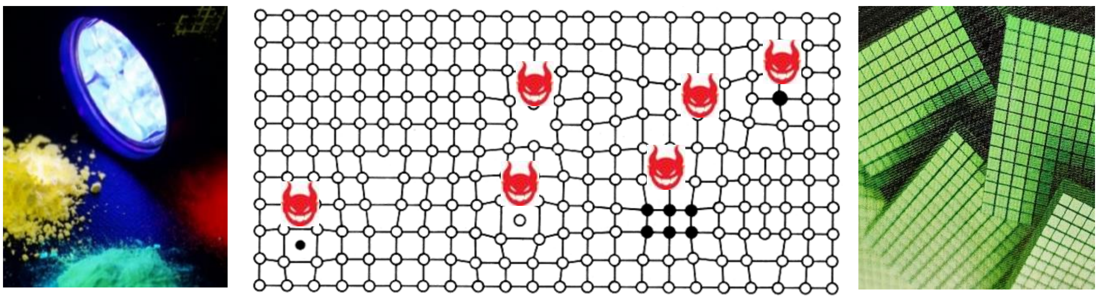

Figure 1 – Schematic illustration of devilish defects in a crystal matrix with on the left and right well-known phosphors for LED lighting (left) and $Gd_2O_2S:Pr^{3+}$ scintillator plates for CT scanners.

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