Trapping and detrapping in phosphors: state-of-the-art and remaining challenges

Electron transfer processes are very important for the functional behavior of luminescent materials as they can cause luminescence quenching, enable energy storage and even induce new radiative decay channels, yet they are poorly understood. A telling example is the one of the glow-in-the-dark material $SrAl_2O_4:Eu^{2+}$, Dy^{3+}, serendipitously discovered in the 1990s and since then unbeaten for applications in watch dials, emergency signage or toys and currently within the scope of novel applications such as stress sensing, photocatalysis or medical imaging. In this talk, an overview will be given of what has been established about trapping and detrapping in this compound and other lanthanide-activated materials. Recent results will be highlighted that have been obtained with nonstandard methods such as high-resolutions X-ray spectroscopy and multiconfigurational *ab initio* calculations, illustrating the usefulness of combined theoretical and experimental approaches and the need to deviate from the beaten tracks.