Probing trap depths in persistent phosphors

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Contrary to most luminescent materials, persistent phosphors can continue emitting light for hours after being excited. It is generally agreed upon that excited electrons can escape the luminescent centers and get caught by so-called ‘traps’ in this kind of materials. A certain activation energy, or ‘trap depth’, needs to be overcome before the electrons can return to the luminescent centers and produce light. Unfortunately, the nature of these traps and the kinetics of the trapping/detrapping process remain the subject of debate [1]. Therefore, the development of better and brighter persistent phosphors, strongly desired for emergency signage and medical imaging, remains a process of trial-and-error.

An effective and versatile approach to study the trap structure in persistent phosphors is thermoluminescence. By heating a previously excited material and simultaneously monitoring the emitted light, information on the trap depths and the trapping kinetics can be deduced. Using this technique, we were able to prove the presence of a continuous trap distribution in the blue-emitting persistent phosphor CaAl$_2$O$_4$;Eu,Nd. Furthermore, we will discuss the major pitfalls when using thermoluminescence for studying the trapping processes in persistent luminescent materials, and how they can be avoided.