

Basics and quirks of thermoluminescence and optically stimulated luminescence

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Many luminescent materials feature non-luminescent defects, which can act as charge trapping defects. This can lead to a strongly delayed emission after exciting the material, a feature that is used in glow-in-the-dark or persistent phosphors, certain dosimetry materials, storage phosphors, mechanoluminescent materials etc. Typically, heat, pressure or photons are used to release the trapped charges, after which emission of light occurs. To study the behaviour of those materials, one often turns to measurements of the thermoluminescence (TL; where the temperature of the sample is increased at constant rate) and/or the optical stimulated luminescence (OSL; where the sample is irradiated with light of certain energy). This yields information on the total number of trapped charges, the optical response of trapped charges¹, the energy needed to release the charges (related to the trap depth²), non-radiative decay paths...

In this tutorial lecture, we start from the basics of TL^{2,3} and OSL³ measurements, and the associated guidelines to perform accurate and reproducible measurements. In a second step the focus lies on what information can be extracted from those measurements, especially in view of extracting trapping parameters (such as trap depth distributions⁴) which is not as straightforward as it might seem. A particular aspect is the issue of overfitting thermoluminescence glow curves in the case of multiple trap depths. Special attention is given to the often strong role of thermal quenching processes, and how to avoid this interference⁵.

Finally, the use of more advanced TL and OSL measurements is illustrated by some specific cases where those measurements proved pivotal to understand the underlying mechanism of trapping and detrapping processes^{1,5}.

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