Influence of traps on scintillators performances: examples of Thermally Stimulated Luminescence investigations

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The fundamental knowledge of defects in a material is of crucial importance in order to understand the energy transfer and trapping processes occurring during irradiation with ionizing radiations, especially if application for radiation detection as scintillator or dosimeter is foreseen.

Point defects can give rise to localized energy levels in the forbidden gap trapping free carriers during irradiation; in a scintillator, carrier trapping by defects can compete with the prompt scintillation process.

In the research field of scintillators such defects are qualitatively separated in two broad families, usually named "deep" and "shallow" traps. Deep traps are those with a lifetime much longer with respect to the scintillation decay time; they trap carriers in a stable way and really lower the scintillation light emission. On the other hand, "shallow" traps have a lifetime longer but comparable with respect to the scintillation decay time, so that carrier de-trapping from such states and subsequent radiative recombination causes slow scintillation tails and thus alters the timing properties of the scintillator.

Thermally stimulated luminescence (TSL) studies are frequently employed for the investigation of traps; wavelength resolved measurements, where the amplitude of the TSL emitted light is measured both as a function of temperature and wavelength, allow to find simultaneous information about traps and emission centres and are particularly useful for a satisfactory understanding of the trapping-recombination processes.

The lecture is devoted to a description of the investigation of traps by wavelength resolved TSL measurements, with emphasis on experimental aspects as well as on data analysis. Methods and experimental procedures aimed at the evaluation of trap parameters are presented and compared, in order to give a picture of the potential and limits of this high sensitivity technique. The discussion is also grounded on representative examples concerning TSL studies in selected scintillator materials featuring different trapping-recombination mechanisms, like crystalline silicates, perovskites, and garnets.