# Excitation dynamics and efficiency of luminescence of Eu in GaN

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While blue and green LEDs based on GaN are already successfully commercialized, red emission from these materials is still lacking and preventing monolithic full-color displays. Eu-doped GaN attracts special attention due to its intense emission and temperature insensitive wavelength stability around 622 nm. In order to improve the luminescence output of these materials it is important to understand the energy transfer dynamics from the GaN-host to Eu ions, as well as the limitations hereof. Here we present a comprehensive study on the ultrafast carrier dynamics, energy transfer mechanism and luminescence quantum efficiency (QE) of this material. It is shown that the QE is strongly dependent on the excitation conditions and can reach nearly 30% at room temperature (Fig. 1). For a small excitation fluence there is an efficient carrier trap that competes with the Eu-related trap, but which limits its influence when all of them are filled. The timescales involved in the carrier trapping have been determined by means probing the carrier dynamics. Two distinct time constants are found in the carrier dynamics, which can be related to the efficient trap and the Eu-related trap by means of their abundance and carrier capture cross-sections. A schematic model showing both processes, with their associated time-constants, is depicted in Fig. 2.

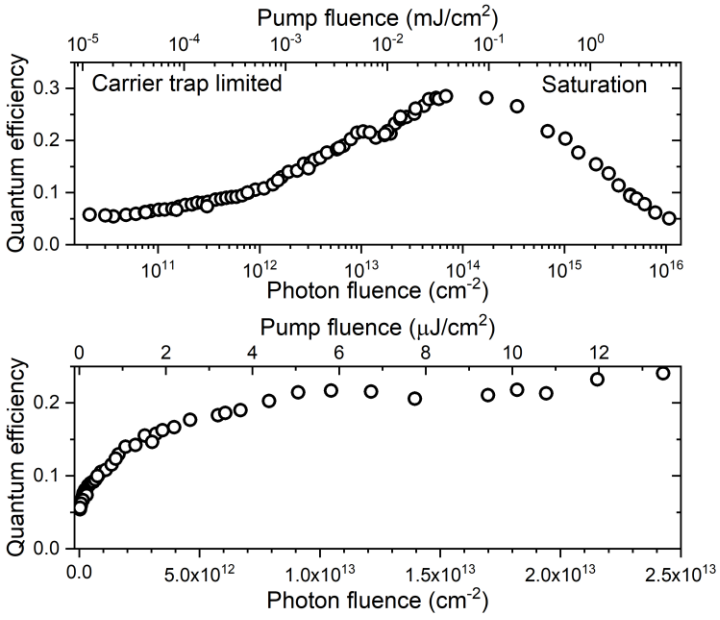


Fig. 1. PL QE of Eu-related emission as function of excitation photon fluence.

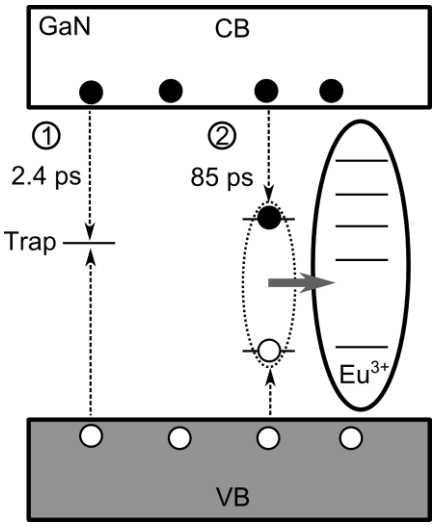


Fig. 2. Schematic model showing the two competing processes and associated timescales underlying the carrier dynamics.