Photoionization Models For Electron Emission From Deep Trap Levels in n-GaN

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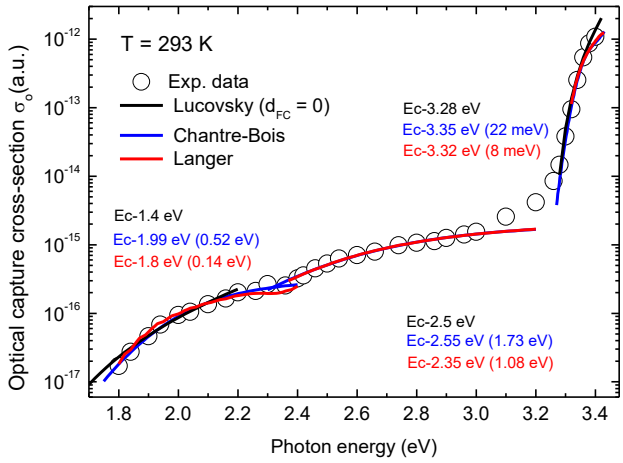
To study relatively shallow levels in GaN, the Deep Level Transient Spectroscopy (DLTS) [1] is commonly used, even though the midgap states are thermally inactivated and do not contribute to measured signal. In $Al_xGa_{1-x}N$, the situation is even worse. To analyse the midgap states in the wide bandgap materials, Deep Level Optical Spectroscopy (DLOS) [2] technique can be applied. In DLOS method, for incident photon energies equal to or higher than the optical ionization energy threshold (E_0), carriers are optically promoted to the bands. Moreover, it is widely accepted that in GaN some defects can strongly interact with the lattice and cause increase of energy needed to emit the carrier from deep level by a factor referred to as non-zero Franck-Condon energy (d_{FC}). Both parameters can be determined from DLOS measurements.



In this paper, we analyse and compare different theoretical models that provide approximations of spectral density of the optical capture cross-section (σ_0), which was experimentally determined from DLOS measurements carried out on semi-transparent Ni/Au Schottky barrier diodes (SBDs). Those diodes were fabricated on n-GaN samples grown by MOVPE technique on Ammono-GaN substrates. For data fitting, we used both: the theoretical models assuming no latttice relaxation ($d_{FC} = 0$) such as Lucovsky model [ref] as well as models with non-zero lattice relaxation energy such as Chantre-Bois [2] and Langer [3], respectively. Finally, the photoionization (E_0) and Franck-Condon energies (d_{FC}) were estimated with these theoretical models and they are discussed in this paper.

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