Engineered defects in 4H-SiC p-n diode for Quantum Computing and Simulation

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Abstract: Engineered defects, electrically driven at RT in 4H-SiC p-n junction diodes, were studied. Electro-Luminescence peaks were observed and correlated to the presence of color centers in the spectral range of Silicon Vacancies.

An innovative area of research is the study of point defects in WBG materials for Quantum Computing and Simulation. 4H-SiC, widely adopted for power electronics and sensor devices fabrication [1-6], is recently investigated for its specific point defects (vacancy-type color centers) that can also trap carriers. They exhibit single-photon emission, useful for Single Photon Source (SPS) applications and quantum entanglement between trapped charge spin and photon, permitting, as long-term goal, to create a quantum network, which includes quantum communications nodes and quantum memory [2-6]. We recently explored the possibility to introduce defects in SiC by applying a controlled mechanical stress into a SiC p-n junction diode trough nano-indentation procedure and we investigated the modification of the diode parameters with respect to virgin one [4]. In this work, further investigations were performed, and the Electro Luminescence (EL) spectra were acquired. EL emission of devices subject to nano-indentations with a 5 mN and 15 mN maximum indentation load respectively were investigated versus the injection current of the diode as shown in figures. A large prominent band centered at around 490 nm, is present in all the devices; this EL peak, widely reported in literature [1, 4], is related to typical intrinsic and processing SiC defects such as Z1/Z2, Carbon Vacancies and stacking faults (SFs). Our analysis reveals that nano-indentation induces a significant change in the EL spectra in the NIR. The appearance of some new signals in the nano-indented devices in the range between 700 nm and 900 nm are attributable to point defects such as color centers, related to Si vacancies, and their intensity increase with the pumping current [4]. Figures show the presence of a proportional dependence of the EL signal, at selected energy levels, respect to the device pumping current, for both #15mN (left) and #5mN (right) samples respectively, compared to as-fabricated diode (# virgin). This work highlights the potential of engineered defects as a tool for tuning the performance of SiC-based devices and for obtaining color center in a controlled way, of great interest in the contest of the NQSTI project and more generally for Quantum Computing applications.

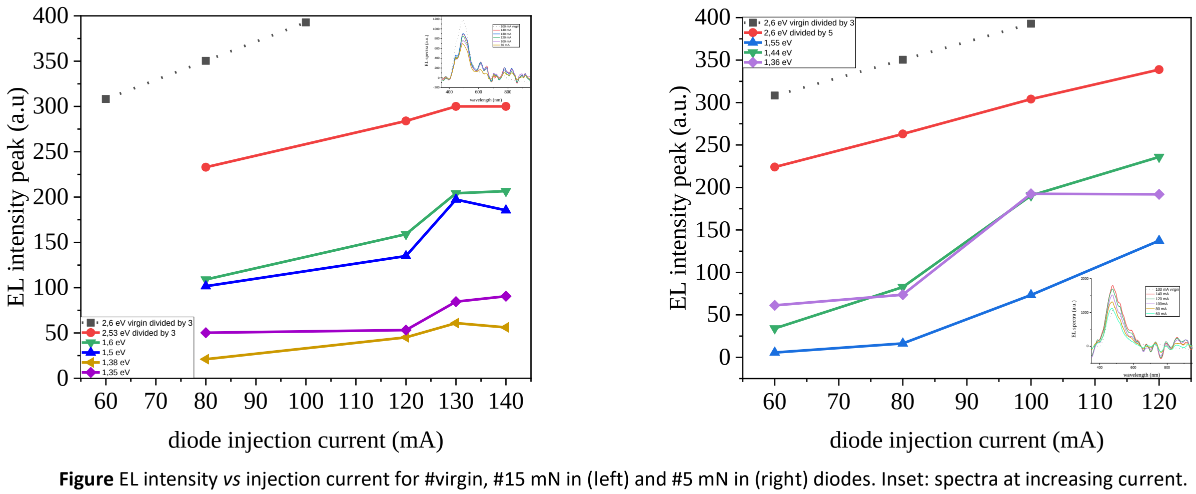

Figure EL intensity *vs* injection current for #virgin, #15 mN in (left) and #5 mN in (right) diodes. Inset: spectra at increasing current.

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