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Wide Injection Range OCVD System for Lifetime Spectroscopy Techniques

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To continually increase the voltage and current capabilities of power semiconductor devices, whether pushing older materials such as Si to its'intrinsic electrical limits or by employing newer substances like SiC or GaN, a thorough understanding of the entire device is required, from the basic physics of the material and its interactions with defects and passivation, up to the complete device structure, including terminal performance and device - level limitations. Of the fundamental parameters that affect device performance, the most complex and malleable is the carrier lifetime. Carrier lifetime has a profound effect on power devices designed for high voltage applications and power devices relying on conductivity modulation. This parameter cannot be given as a ball -park figure unlike mobility (and hence diffusion coefficients) as it is affected by nearly every processing step a device undergoes: a final device can have carrier lifetimes that differ drastically from the starting bulk material. The work herein utilizes a relatively new set of techniques collectively known as Lifetime Spectroscopy (LS) methods to extract fundamental material parameters relating to recombination activity: τn0, τp0 and ΔEt. These LS methods directly measure recombination activity of defects and hence acquire characteristic data of defects and dopants that is complimentary in nature to the information gleaned about them from more orthodox methods such as Deep -Level Transient Spectroscopy (DLTS). The Open Circuit Voltage Decay (OCVD) method is used along with improved data manipulation algorithms to extract the effective carrier lifetime as injection and temperature are swept. A complete stand -alone system has been constructed that allows a very wide range of current injection (~1mA to > 200A) and built -in OCVD waveform acquisition. The first complete Temperature -Injection Dependent Lifetime Spectroscopy (T-IDLS) studies are carried out on a small signal PiN commercial diode.

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