Single-photon and two-photon DC and RF optical beam induced current microscopy of InGaN light emitting diodes

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Indium Gallium Nitride (InGaN) light emitting diodes (LEDs) have found applications in areas as diverse as full-colour display, liquid crystal display back-lighting and in mobile platform technologies [1]. Given the prevalence of InGaN devices in real-world applications, non-destructive methods for quantitative assessment of performance are required.

Optical beam induced current microscopy (OBIC) presents a practical and non-destructive method to study the active region within such semiconductor devices. By using a laser scanning microscope to irradiate a sample with light of an energy equal to or above that for the bandgap of the device, an electron-hole pair can be created. The resultant induced current flow can then be detected and used to create information on the integrity and homogeneity of the sample. When using OBIC for analysis of high-speed devices such as LEDs, the high frequency AC component of signal transmittance is often of more interest than the generated DC frequencies. Such devices also generate a signal at radio frequencies (RF OBIC) and this can provide additional information about samples when compared to DC OBIC [2]. RF and DC OBIC are possible in either a single-photon or two-photon geometry [3], although the excitation source requirements are clearly very different.

In this study we present the benefit of combining both two-photon OBIC and RF OBIC for analysis of InGaN light-emitting diode devices. By using a combination of wavelength tuning of the Ti:Sapphire excitation source and alteration of the modulation frequency of the electro-optic modulator (EOM), we will report the optimal excitation conditions for extracting the greatest OBIC signal.

We will also report, for the first time, the application of a white-light supercontinuum source for single-photon OBIC microscopy of InGaN LEDs and the possibility for further laser development to assist with improved imaging.

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