TIME-RESOLVED OPTICAL BEAM INDUCED CURRENT IMAGING WITH THE FREQUENCY DOMAIN TECHNIQUE

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1. INTRODUCTION
Optical beam induced current mapping has found wide-spread applications in charactering semiconductor devices and integrated circuitry, especially in locating defects within active regions. Through the use of ultrafast laser, the temporal response can be mapped with high spatial resolution. The ultrafast laser pulses enable excitation with extremely broad bandwidth that greatly exceeds the one provided by conventional electronics methods. The temporal response of a device is a function of its configuration and carrier dynamics that is often reflected by the strength of radio frequency (RF) signal generated with laser pulse excitation [1]. However, the RF strength alone is insufficient in resolving the temporal characteristics of a device due to the lack of phase information.

2. TIME-RESOLVED MAPPING WITH FREQUENCY DOMAIN TECHNIQUE

Figure 1: The epi-illuminated image of the silicon PIN diode is shown in (a). The OBIC mapping with (b) DC (c) X-channel at 0V bias (d) the corresponding Y-channel (with 90° phase shift relative to the X-channel) also at 0V bias (e) X-channel and (f) Y-channel at 4.0V bias.

Through the employment of time-resolved technique at frequency domain, the temporal response of the device can be inferred from the phase delay of OBIC signal relative to the repetitive laser excitation [2]. The laser scanning microscope employed in this study is modified to synchronize the image acquisition with the lock-in detection. We are demonstrating this new method over a variety of samples. As shown in Fig. 1, the dark upper part of the photodiode reflects this part’s slower response to pulsed laser excitation since the RF phase lock loop is effectively an AC filter that rejects DC response from the sample. In contrast, the area near the metallic electrode in the lower part reveals a much greater response at high frequency. The two channels (color coded in green and red) provide complete information to reconstruct the temporal behavior of the device.