

# HIGH DEFINITION SCANNING IMAGING THROUGH MODULATED DETECTION

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## 1. Introduction

Laser scanning microscopy is a power technique in various studies and disciplines. Its basic working principle is to scan a focused laser beam over the sample in a pixel-by-pixel manner through a scanning mechanism, such as galvano-mirrors or moving stages. The contrast of an image may come from reflectivity, fluorescence, nonlinear harmonics signals, photocurrent...etc. However, the signal-to-noise (S/N) ratio of an image may suffer greatly when observing a sample of low signal level. Additionally, the low frame rate (~1 frame/second) of a common scanning microscope prevents observation of any event of dynamical nature. Even when a video-rate scanning mechanism, such as rotating Nipkow disk, is employed, the frame rate (~10 frames/second) is still far from sufficient for events of short response time. We are demonstrating in this presentation that both the S/N ratio and temporal resolution (of synchronous nature) can be greatly improved by integrating modulation and lock-in electronics into the scanning imaging system.

## 2. Modulation and lock-in detection

The technique of modulation and phase detection after homodyne mixing is widely used in many electronics and signal processing setups, with lock-in detection as a well-known example. In this

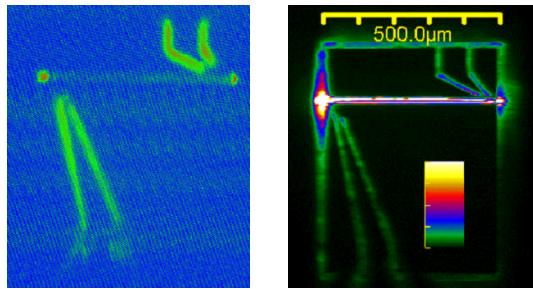


Figure 1 (a) A conventional OBIC image of an electro-absorption modulating device (b) The improved OBIC image with modulation /lock-in detection.

way, the S/N ratio is greatly enhanced by rejecting out-of-sync noise. Additionally, the temporal response of the contrast signal for imaging can be inferred from its phase delay relative to the modulation. The laser scanning microscope employed in this study is modified to accommodate external trigger signal so as to synchronize the image acquisition with the lock-in detection. We are demonstrating the projected features and improvements over a variety of samples. As shown in Fig. 1, the optical beam induced current (OBIC) images from an electro-absorption modulating device is greatly improved with the employment of lock-in detection.

## References

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