HIGH CONTRAST SUBSURFACE THERMAL IMAGING BASED ON NEAR-INFRARED LASER SCANNING CONFOCAL MICROSCOPY

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Thermoreflectance microscopy (TRM), which is based on measuring the relative reflectivity changes ($\Delta R/R$) depending on the temperature changes (ΔT), is a powerful tool for characterizing of thermal distribution on semiconductor micro-structures with the high spatial and thermal resolutions [1, 2]. However, for the thermal measurement of devices hidden under the encapsulant or substrate material, sensitive thermoreflectance ($\Delta R/R$) measurements are more difficult to obtain. This is because the dynamic range of the thermoreflectance measurement can be reduced by additional reflections from the obstruction's surface.

In this paper, we present TRM using the confocal microscope's optical sectioning capabilities with a NIR illumination for subsurface thermal imaging. We demonstrate high contrast thermoreflectance measurement based on the laser scanning confocal microscope that can only detect the reflected light from the device without the multiple reflection effect. In order to do a through substrate thermoreflectance measurement, Fourier domain filtering method and back-side NIR illumination (1150nm) were employed.

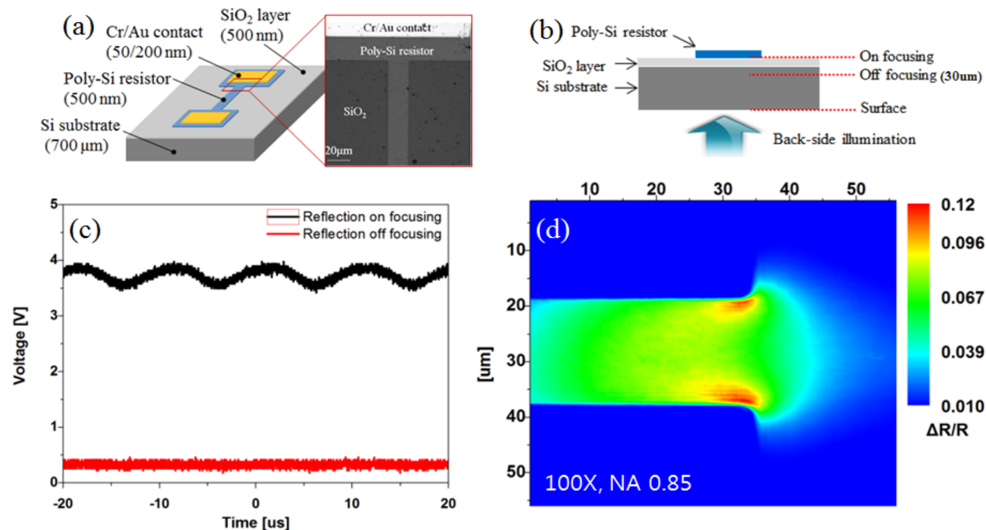

Figure 1. (a) Sample design, (b) Schematic of back-side illumination, (c) Reflection contrast between on and off focusing, (d) Confocal thermal image of the sample. At 100 kHz, electrical modulation.

Reference

[1] M Farzaneh et al., "CCD-based thermoreflectance microscopy: principles and applications", *J. Phys. D: Appl. Phys*. 42, 143001, 2009.
[2] D. U. Kim et al., "Quantitative temperature measurement of multi-layered semiconductor devices using spectroscopic thermoreflectance microscopy", *Optics Express*, 24, 13906-13916, 2016.