Infrared Thermography for Nanoscale

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Infrared (IR) thermography has shaped itself as a versatile tool, from undertaking basic non-destructive testing to complex sample and materials characterization. Starting from the macro domain, the scale of applications has also been extended to objects and materials at micro scale. Submicron diffraction-limited spatial resolution characterization of activated MOSFET devices through thermoreflectance thermography, has been reported (Komarov et al). Lock-in IR thermography has been used to study leakage current in MOS materials down to 5μm lateral resolution (Huth et al). Further, a lateral resolution of 1.4 μm has been achieved (Ünlü et al) using high resolution backside imaging through a numerical aperture increasing lens (NAIL). In a very different vein, this presentation will focus on extracting properties at nanoscale from IR thermography measurements at micro/macro level. Two such applications are discussed; for thermal characterization of templated nanomaterials and degradation study of organic light emitting diodes (OLEDs).

Porous anodic alumina (AAO) templates are used very extensively in the growth of nano-structured materials, but thermal characterization of such templated nanomaterials pose a great challenge because of their extremely delicate and fragile nature. A novel approach for thermal diffusivity measurement of these nanomaterials in radial direction will be discussed using the concept of conventional lock-in thermography. The distinctive feature of the method is its simple data analytic approach, based only on the phase information. The techniques performance and operational time is further improved by the use of frequency modulated thermal wave imaging.

Organic Light Emitting Diodes (OLEDs) are a relatively new but extremely important technology for displays and lighting. Comprising nano dimensioned layers, a substantial fraction of the supplied electrical power was found to be transformed into heat due to resistive and non-radiative losses inside the OLED. This generated heat leads to the creation of additional non-radiative centers inside the OLED, which further increases the device temperature. Resistive losses can be suppressed by inserting an hole injection layer, which reduces the interface resistance. Device temperature gets reduced significantly by this insertion. IR thermography has been used to monitor OLED temperatures. The temperature measurements have been used to optimize the thickness of hole injection layer for enhanced efficiency and long durability of OLEDs. These measurements have been correlated with the operational time dependent brightness data. IR thermography has been explored to efficiently monitor the heating in OLEDs and this technique will further be useful for the proper thermal management in these devices.

Keywords: Infrared thermography, Thermal diffusivity, Nanocomposite, OLEDs.