FAILURE ANALYSIS OF INTEGRATED CIRCUITS USING OPTICAL THERMOGRAPHY AND SPECTROREFLECTANCE MICROSCOPY

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We demonstrate failure analysis of integrated circuits (IC) at optical resolution (~ 1 µm) using an optical feedback laser diode confocal microscope. By acquiring the reflectance and the optical-beam-induced current (OBIC) images at each point on the sample, it is possible to discriminate the semiconductor from the metallic sites in integrated circuits[1]. Such spatial classification reveals the nature of defect and probable cause of failure.

Differential thermal maps[2] of semiconductor are derived by detecting changes in the OBIC signal that are produced in the active layer in response to variations in the IC package temperature. The thermal maps show locations of high thermal activity in the active layer including anomalous regions where the OBIC outputs decrease with increasing temperature. These anomalous regions are loci of accumulating semiconductor electrical resistance and provide the best jump-off points for efficient and accurate IC fault analysis procedure.

Aside from absorption, reflectance can also yield thermal information about the IC. We construct a versatile and cost-effective spectral microscope for generating spectral reflectance maps that distinguish subtle differences in performance among various semiconductor components in the active layer of an integrated circuit (IC) sample. A grating-prism pair (GRISM) system is utilized to disperse reflected light into its spectral components. Thermal maps are generated from a biased-unbiased image pair to reveal regions of rapid heat accumulation. The benefit of spectral selectivity is demonstrated further by determining the reflectance properties of a biased light emitting diode in the presence of a strong electroluminescence background. Spectral unmixing is employed to remove the background and isolate the thermal maps, which facilitates the difficult task of thermography in functional light emitting devices.

Finally we demonstrate the feasibility of imaging IC defects remotely by controlling an Olympus BX-61 motorized microscope through a web interface via internet, and through a mobile phone using SMS and GPRS. Captured images can be viewed via the web interface, sent through MMS or live-video streaming. Remote imaging and control of the microscope enhances collaborations between researchers without the need to be physically present on the experimental site.

 References: