MRS 2002 FALL MEETING

Symposium G
Spatially Resolved Characterization of Local Phenomena in Materials and Nanostructures

Session G12
Optical Probed of Nanostructures
2:00 PM Thursday December 5, 2002
Room 200 (Hynes)

G12.3

Immersion Lens Microscopy of Photonic Nano-structures and Quantum Dots

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We describe recent experimental and theoretical advances in immersion lens microscopy for both surface and subsurface imaging as applied to photonic nanostructures. Standard optical microscopy is not capable of obtaining a transverse resolution with a definition better than approximately half a wavelength of light due to the diffraction limit, also termed the Rayleigh or Abbe limit. The resolution is inversely proportional to the Numerical Aperture (NA). One method to increase the NA is to increase n, the refractive index of the material in the object space. We describe a new technique involving a Numerical Aperture Increasing Lens (NAIL) for diffraction limited subsurface microscopy. The NAIL technique is demonstrated by near-IR inspection of Si integrated circuits yielding a 230 nm resolution at 1050 nm wavelength. This resolution represents a factor of 4 improvement over the state-of-the-art. To the best of our knowledge, this is the first proof of subsurface microscopy using solid immersion lens technique. We also examine in detail the ability of sharp metal tips to enhance local optical fields, explaining the main issues for nanometer resolution microscopy and spectroscopy. Finally, we describe a new approach to nano-optics, that of combining solid immersion microscopy with tip-enhanced focusing and show how such an approach may lead to 20nm resolution with unity throughput.