A COMPUTATIONAL MODEL FOR APLANATIC SOLID IMMERSION LENS SCANNING MICROSCOPE

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KEY WORDS: Scanning Microscopy, Solid immersion lens, Computational imaging

Solid immersion lens (SIL) [1] microscopy provides not only higher spatial resolution and improved light collection efficiency due to its high NA, but also the capability of subsurface imaging with good resolution if the refractive index of the substrate is the same as that of the SIL [2, 3]. This technique has been experimentally employed to enhance resolution and imaging performance of wide-field microscope [4] and scanning microscope [5] in the field of imaging solid state devices, especially semiconductor integrated circuits.

In this presentation, a complete and computation efficient model of aplanatic solid immersion lens (ASIL) scanning microscope with finite-sized detector, as shown in Fig.1, is presented. The concept of secondary sources and several fast algorithmic approaches have been employed. The secondary source on object structure induced by the focused light produce the image in the focal plane of detector lens. The object structure in the focal plane of ASIL is assumed to be scanned relative to the optical system, and the total intensity is measured with a detector of finite size. Simulations of imaging object structures are designed to analyze image formation of ASIL scanning microscope using linearly and circularly polarized illumination of wavelength, $\lambda = 1340$ nm in free space. As an example, Fig. 2 shows the original pattern and image of letters “NUS” using linearly and circularly polarized illumination. This model lays the groundwork for optimizing ASIL scanning microscope imaging parameters and further improving the resolution of the scanning system.

![Fig. 1 Diagrammatic description of ASIL scanning microscope. The path of the rays with red arrow represents the incoming wave and the path of the rays with green arrow for the scattering wave. The refractive index of ASIL is the same as that of substrate where the object structures locate.](image1)

![Fig. 2 (a) The original pattern of letters ‘NUS’ and its image using proposed optical model of ASIL scanning microscope for (b) Linearly polarized illumination and (c) Circularly polarized illumination. The radius of pinhole is 25μm. The horizontal and vertical coordinates are [-0.87 0.87] and [-0.42 0.42] for $x_{sil}(\lambda)$ and $y_{sil}(\lambda)$, respectively. In (a), the letter width is $t = 0.05\lambda$ and the distance between letter is $d = 0.25\lambda$. The refractive index of letters and the substrate is 1.5 and 3.5, respectively.](image2)