

# RIGOROUS SIMULATIONS OF CONFOCAL MICROSCOPES IMAGING SURFACE RELIEF STRUCTURES: RESULTS.

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## 1 INTRODUCTION

Confocal microscopes are commonly used to make surface profile measurements. For example, they are used monitor the quality of lithographically produced structures. Also, polarisation sensitive confocal microscopes are also used to read Multiplexed Optical Data Storage (MODS) media [3] which are composed of surface relief structures. Confocal images of such samples have been simulated previously, see for example references [1,2], such calculations are either not rigorous or perform only line scans as opposed to full surface scans. In this talk we present what we believe are the first rigorously calculated confocal images, as opposed to line scans, of surface relief structures.

## 2 RIGOROUS SIMULATIONS

We present the first two-dimensional results using our recently published rigorous model of high numerical aperture vectorial imaging in coherent optical microscopes [4]. Figure 1 shows a portion of the results obtained from calculations performed for comparison with experimental results. Significant computational resources were required to calculate these images as nearly  $10^4$  Finite Difference Time Domain (FDTD) calculations were performed. Much attention must be paid to computational efficiency in order to practically accommodate such a computational burden without compromising the rigour of the solution.

Much insight may be obtained from these simulations. For example, Mueller matrix microscopy may be simulated by calculating images for both x- and y-polarised incident light. This then enables optimal detection strategies to be formulated for our MODS system. Furthermore, the role of the pin hole in such an optical system may be examined producing surprising results.

In this presentation we will present new results arising from the rigorous calculation of confocal images of samples such as that shown in Figure 1(d). In addition to simulated confocal and large area detector images, simulated Mueller-matrix microscopy images will be presented revealing new ways in which such surface relief structures may be studied using confocal microscopes.

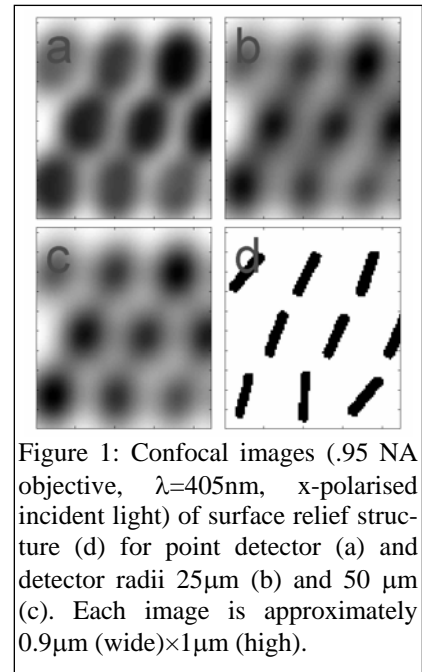


Figure 1: Confocal images (.95 NA objective,  $\lambda=405\text{nm}$ , x-polarised incident light) of surface relief structure (d) for point detector (a) and detector radii  $25\mu\text{m}$  (b) and  $50\mu\text{m}$  (c). Each image is approximately  $0.9\mu\text{m}$  (wide) $\times 1\mu\text{m}$  (high).

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