BRISTOL CENTRE FOR FUNCTIONAL NANOMATERIALS

University of BRISTOL

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Abstract Submission Form

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Brief description of research activities:

My scientific interest is in pushing optical detection and imaging technologies to help address challenging questions by researchers working in other areas of research. Through this I have gained expertise in developing single molecule/particle imaging techniques as well as in the development of techniques capable of visualizing the propagation of femtosecond pulses inside integrated photonic devices. We have experience in Near-Field Scanning Optical Microscopy (both collection and excitation mode), Interferometry, Confocal Microscopy, UHV-STM, AFM, single molecule and single particle detection, plasmonics and the use of ultrafast optical techniques.

Presentation title:

Polarisation State Imaging in High Numerical Aperture Systems

Presentation abstract:

The potential for polarized light to highlight specific structures, such as filaments and membranes, in a living cell has long been known [1]. However, it still remains difficult to image these weakly birefringent structures due to depolarization of light at interfaces and weak signal levels when imaging through crossed polarisers. To address both these issues, we have introduced a confocal-like microscopy approach, Interferometric Cross-Polarisation Microscopy(ICPM) that has demonstrated the ability to resolve small polarisation signals against large backgrounds [2-4]. This interfometric approach allows imaging at high extension ratios with the low illumination needed for single molecule fluorescence and bio-imaging experiments.

As interferometric approaches, such as ICPM, detect fields rather than intensity one can in principle obtain all possible information on the interaction of the sample with light through controlling the polarisation states used during excitation and detection. However in realistic imaging applications this is complicated by the depolarization effects intrinsic to high numerical aperture (NA) objectives. Here I will explore this in detail by discussing our recent results on imaging individual and pairs of nanosized scatterering objects with controlled geometry, separation as well as orientation. Our results provide clear evidence for the importance of incorporating depolarization, including the spatial distribution of field-components, by high-NA objectives in polarimetry.

Selected publications:

[1] R Oldenbourg, ED Salmon and PT Tran, "Birefringence of single and bundled microtubules", *Biophys. J.,* **74,** 645-654 (1998)

[2] X Hong, EMPH van Dijk, SR Hall, JB Götte, NF van Hulst, and H Gersen, "Background-Free detection of single 5nm nanoparticles through Interferometric Cross-Polarization Microscopy", *Nano Lett.*, *11*, pp 541–547 (2011)

[3] BT Miles, AB Greenwood, BR patton and H Gersen, "All-Optical Method for Characterizing Individual Fluorescent Nanodiamonds", *ACS Photonics*, Vol. 3, 343-348 (2016)

[4] BT Miles, X Hong and H Gersen, "On the complex Point Spread Function in Interferometric Cross-Polarisation Microscopy", *Optics Express*, Vol. 23, Issue 2, pp. 1232-1239 (2015)