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Foreword

Frontiers in Optical Bio-Imaging and Microscopy

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The symposium Frontiers in Optical Bio-Imaging and Microscopy took place at the Suntec Conference Centre in Singapore from 26 June to 1 July 2011 as part of the wider Materials Research Society of Singapore's (MRS-S) International Conference on Materials for Advanced Technologies (ICMAT) series. This symposium was held over six days and was chaired by Colin Sheppard, Brahim Lounis, Dave Fernig, and Jonathan Hobley, combining their respective knowledge on optical design, biological imaging, spectroscopy, and photochemistry. The parent biennial ICMAT event has been held on six previous occasions since its inauguration in 2001 and aims to promote multidisciplinary materials research, not only in Singapore, but especially in Asia and beyond. In this context the subject of this particular symposium typifies the scope of the ICMAT series, since modern microscopy is no longer just an exercise in advanced optics – it is in fact a combination of optical design, the chemistry of probe design, and chemistry required to attach novel probes to relevant targets that we wish to observe. In addition, the spectroscopic and photochemical features of probes need to be understood and harnessed in order to enhance their usefulness. For this reason, modern advanced microscopy can truly be considered to be a highly multidisciplinary research field. In the field of modern optics, it is no longer enough to simply envisage a concept in imaging alone; once the concept is born, it is often necessary to work with organic chemists and preparative nanoparticle scientists in order to produce an appropriate model probe system for the desired observation. For example, the most modern super-resolution techniques of PALM, STORM, and STED all require specific fluorescent probes with well tailored photochemistry in order to work. Equally recent developments in photo-thermal tracking of biomolecules require specifically designed noble metal nanoparticle probes as labels for the biomolecule of interest. Probe design is therefore now nearly as important as optical design in this field. Each of the individual component parts of a new bio-imaging methodology is of equal importance in the success and applicability of the technique.

This Research Front comprises a selection of papers that exemplify the current trends in modern microscopy and optical methods presented in the Frontiers in Optical Bio-Imaging and Microscopy symposium, with particular emphasis on the chemical design of probes and the observation of chemical phenomena. In particular, two papers deal with advanced optical design, and three papers deal with advanced probe design.

In optical design, Yakovlev et al.[1] present work on the use of stimulated Raman photo-excitation coupled with acoustic detection as means of locating and imaging specific chemical signatures in a sample. Siebenhofer et al.[2] describe the development of a novel optical design for determining the nanosecond kinetics of processes in bio-mimetic films based on Brewster-angle reflectometry.

In probe design, Free et al.[3] present work on the development of monovalently labelled silver nanoparticles stabilised by peptide shells that are resistant to ligand exchange and non-specific binding for use in bio-imaging applications. Paramelle et al.[4] describe their work on the stabilisation of gold nanoparticles for use as bio-imaging probes. In particular, they show how the shell design affects the overall stability of the nanoparticle. In this work, they present a rapid screening protocol for determining nanoparticle stability. Zhang et al.[5] describe the preparation of polyethylene glycol-protected gold nanorods that are bio-compatible for use in multiphoton luminescence imaging in cells. In this way, their paper describes both state-of-the-art nanoprobe development and cutting edge imaging methodology.

The next ICMAT event will be held in the summer of 2013, and it will once again combine multidisciplinary research in biology, materials science, and optics. We will be looking forward to hosting international scientists in Singapore once again for this event.

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Jonathan Hobley completed his undergraduate studies in applied chemistry at Nottingham Trent University and his Ph.D. in ultrafast spectroscopy on photochromic dyes at Loughborough University. He worked as a Higher Scientific Officer at the UK Atomic Energy Authority Harwell Labs in radioactive wate management R&D, followed by a brief stint at Sussex University studying xanthine oxidase kinetics. After completing his Ph.D., he obtained a Marie Curie Research Fellowship and worked in Great Lakes Chemical Italia, studying photochromic systems. He also obtained an STA Fellowship with the Advanced Photon Research Centre, Osaka, and conducted research in Raman-induced Kerr effect spectroscopy and laser ablation. He then moved to the chemistry department of Tohoku University in Sendai and worked as an Assistant Professor, studying phase change dynamics, ultrafast spectroscopy, and STM. He joined IMRE in July 2006, becoming a Senior Scientist in 2009. His areas of interest are in optical pump probe laser techniques and microscopy.