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Understanding complex thin films at the nanoscale

Numerous new technologies rely on understanding the key role of nanoscale properties in defining the performance of electronic and optoelectronic devices. This has required the development of new measurement techniques, that can probe different device properties at increasing spatial resolution. However, despite significant progress, existing nanoscale characterisation techniques normally can only measure either electrical or spectroscopic properties, but not both simultaneously. This makes correlation of structure and property very challenging. Additionally, high-resolution information is rarely obtained simultaneously in all three dimensions. For instance, scanning probe measurements allow high lateral resolution but are typically surface techniques, with poor information about the subsurface. In this presentation, we demonstrate a novel method that allows non-destructive, simultaneous measurements of topographical, electrical and optical microscopy at the nanoscale (<20 nm resolution) by combining tip-enhanced optical spectroscopy (photoluminescence and Raman) with photocurrent AFM. We demonstrate that this approach offers subsurface sensitivity that can be exploited to provide molecular information with nanoscale resolution in all three spatial dimensions. We apply this method to organic solar cells and show that we are able to correlate local nanoscale composition to photocurrent generation, including the direct identification of impurities within nanoscopic domains of operating solar cells. The multi-parameter measurement approach demonstrated here, allows to directly identify the impact of film nanostructure on optoelectronic function and avoids the challenge associated with post processing image registration, sample contamination or degradation when measurements are performed separately. We expect it will play a significant role in guiding the design of nanomaterial-based optoelectronic devices.

Biography

Fernando A Castro is the Knowledge Leader for the Engineering, Materials and Electrical Science Department at the UK's National Physical Laboratory. He also holds several international roles, such as Chair of TWA36 Organic Electronics of VAMAS, UK Expert within IEC TC119 - Printed Electronics, Associate Editor of the journal *Science and Technology of Advanced Materials*, Member of the Steering Committee of the European Energy Research Alliance – JP Photovoltaics. He has chaired large international conferences on Nanomaterials, Metrology and Photovoltaics, has delivered over 30 keynote/invited talks and has published over 50 papers in high-quality peer-review journals.

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