

Metrology for innovation of next generation semiconductor materials

Fernando ARAUJO DE CASTRO – *NPL, National Physical Laboratory, UK*

Lack of confidence is a major challenge in accelerating innovation of advanced materials and nanotechnologies. This talk will start with a short overview of why reliable and reproducible measurements are so critical to provide that confidence. It will then focus on two examples of advanced metrology for next generation semiconductor materials being developed at NPL, describing two aspects of innovation and upscaling of 2D transition metal dichalcogenide (TMD).

The first example will focus on advanced measurements to understand challenges of integration of TMDs in a device structure. TMDs show promise for optoelectronic applications but are often limited by Fermi level pinning effects and consequent large contact resistances upon contacting with bulk metal electrodes. A potential solution for near-ideal Schottky–Mott behavior and concomitant barrier height control has been proposed in the literature by contacting TMDs and (semi-)metals in van der Waals heterostructures. We will show how combined nanoscale measurements allows to directly access interface parameters relevant to the Schottky–Mott rule on a local scale and how we use Scanning Kelvin Probe Microscopy (SKPM) and Tip-Enhanced Optical Spectroscopy (TEOS) measurements under simulated operational conditions (e.g. electrostatic doping induced Fermi levels) to enable decoupling and quantification of contributions from the interface dipole and electrode work function.

The second example will focus on the challenge of quantifying quality of 2D semiconductor materials for upscaling. Controlling the radiative properties of monolayer transition metal dichalcogenides is key to the development of atomically thin optoelectronic devices applicable to a wide range of industries. Here we show how the traditional approach of single point spectroscopy measurements can be misleading and demonstrate a method to quantify spatial uniformity using statistics of spectral photoluminescence. We discuss the impact of laser induced semiconductor material changes and the results of a VAMAS international interlaboratory study to further develop this method for quality assessment of semiconductor 2D TMDs both in academic and in industrial laboratories.