

A Correlation of Raman and Single and Multiple Layer Graphene Conductivity As Detected With A Cryogenic Multiprobe AFM With On-line Raman, NSOM and Other SPM Modalities

Aaron Lewis*, Oleg Zinoviev¹, Anatoly Komissar¹, Eran Maayan¹, **David Lewis¹**

*Rachel and Selim Benin School of Engineering and Applied Science, The Hebrew University of Jerusalem and

¹Nanonics Imaging Ltd, Jerusalem, Israel
info@nanonics.co.il

It is a challenge to study 2D materials, such as Graphene, MoS₂, WeSe₂, etc. at temperatures down to 100K when considering the wide variety of physical phenomena that must be applied for a full picture of the functionality of these materials. This involves questions of structure, nanometric photoconductivity, electrical properties, thermal properties, near-field optical in the apertured & scattering modes, Kelvin probe, and Raman. These phenomena are common not only to 2D materials but also to carbon nanotubes and related nanomaterials. This presentation will describe the instrumental development of such a multiprobe cryogenic system that allows for state of the art on-line optical measurements and will also include a review of the probe developments that permit such multifunctional multiprobe operation with on-line full optical access. This system has a completely free optical axis from above and below not obscured by electrical or other probes that have been developed for multiprobe operation. This permits on-line Raman and Tip Enhanced NanoRaman Scattering. With such a system we have investigated graphene and HfO₂ using multiprobe electrical, Kelvin probe, NSOM and on-line Raman. The results have yielded new insights into chemical changes correlated to electrical conductivity.