

CCEM, News from the National Physical Laboratory, UK, March 2015

On 1 January 2015, NPL transferred from a Government-owned contractor-operated (GoCo) arrangement under Serco to a Government company as part of the Department for Business Innovation & Skills (BIS). As part of this transition, NPL will be forming a strategic partnership with the Universities of Strathclyde and Surrey. The aim of the partnership is to boost NPL's and the partners' scientific excellence, to strengthen engagement with business, and to make more use of the facilities and the site. An important focus will be to develop activity to support postgraduate research and training at Teddington and across the UK. Having served as Managing Director since March 2009, Brian Bowsher will be retiring from NPL at the end of June 2015.

New Quantum Metrology Institute at NPL

As part of the UK National Quantum Technologies Programme (UKNQT), NPL will establish a Quantum Metrology Institute (QMI) at its Teddington site. This new Institute will cover all of NPL's quantum science and metrology research and provide the expertise and facilities needed for academia and industry to test, validate, and ultimately commercialise new quantum research and technologies. The QMI will be linked to the four new hubs at the universities of Birmingham, Glasgow, Oxford and York, selected after a competitive peer-reviewed process run by the UK Engineering and Physical Sciences Research Council (EPSRC).

NPL Graphene Team and University of Manchester NGI

NPL and The University of Manchester have signed a memorandum of understanding to help move the potential benefits of graphene closer to practical use, by accelerating the commercialisation of the remarkable 2D material. The memorandum was announced by James Baker of the Manchester National Graphene Institute (NGI) and signed at the evening reception of the NPL Graphene Conference.



The two organisations are exploring a number of ways to work together and in the short term we will be collaborating with the NGI on developing protocols and good practice guides to enable commercialisation of graphene.

Paper on the quantum Hall effect in epitaxial graphene published in the American Chemical Society Nano Letters journal

A consortium of NPL, Cambridge, Lancaster, Chalmers and Linköping Universities has published a paper in the journal NanoLetters on the topic of quantum Hall effect in epitaxial graphene. Graphene grown epitaxially on SiC is often accompanied by small patches of bilayer graphene. These patches can have a detrimental effect on the perfect quantisation of the quantum Hall effect and their behaviour needs to be

understood in order to make a useful resistance standard. The paper combines transport measurements, theory and novel scanning gate microscopy. *Nano Lett.*, 2014, 14 (6), pp 3369–3373.

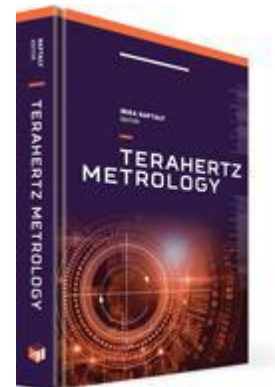
Joint NPL – KRISS electron pump measurements published in Metrologia

“Precision measurement of a potential-profile tunable single-electron pump”. In this paper, accurate operation of a potential-profile-tunable QD-pump device made of multiple top metal gates on a GaAs/AlGaAs 2DEG system is demonstrated. The pump current was measured with a type *B* uncertainty of 1.2 ppm and found to be equal to ef for $0.6 \text{ GHz} \leq f \leq 0.95 \text{ GHz}$, within the total uncertainty, $uT \approx 1.4 \text{ ppm}$. *Metrologia* 52 (2015) 195–200.

Terahertz Metrology book

A book titled “Terahertz Metrology” has just been published by Artech House:
<http://www.artechhouse.com/International/Books/Terahertz-Metrology-2203.aspx>

The book was edited by Mira Naftaly, who was also its main contributing author. Nick Ridler, in collaboration with Roland Clarke of Leeds University, contributed a chapter on vector network analysers.



“This new book describes modern terahertz (THz) systems and devices and presents practical techniques for accurate measurement with an emphasis on evaluating uncertainties and identifying sources of error. This is the first THz book on the market to address measurement methodologies and issues -- perfect for practitioners and aspiring practitioners wishing to learn good measurement practice and avoid pitfalls.

This book provides a brief review of different THz systems and devices, followed by chapters detailing the measurement issues encountered in using each of the main types of THz systems, and a guide to performing measurements rigorously. Particular attention is given to evaluating uncertainties, and recognizing potential sources of errors. The main focus is on time-domain spectroscopy, by far the most widely used technique. Readers are also presented with examples of applications with the emphasis on utility, both in research and in industry.”

Paper on high-frequency measurements published in Metrologia

Nick M Ridler and Martin J Salter, “Evaluating and Expressing Uncertainty in High-frequency Electromagnetic Measurements – A Selective Review”.

This paper was published in a special issue of *Metrologia* that marked the 20th anniversary of the publication of the “Guide to the Expression of Uncertainty in Measurement” (GUM). This special issue features papers related to presentations that were given at an international scientific conference entitled “Guide to the Expression of Uncertainty in Measurement: Past, Present and Future”, which was held at NPL in November 2013. *Metrologia*, Vol 51, pp S191-198, 2014.