

# Terahertz Photonics: from ultra-stable quantum cascade lasers to nanowire photodetectors

Miriam S. Vitiello<sup>1,2</sup>

<sup>1</sup> NEST, CNR - Istituto Nanoscienze and Scuola Normale Superiore, Piazza San Silvestro 12, 56127, Pisa, Italy

<sup>1</sup> CNR- Istituto Nazionale di Ottica and LENS (European Laboratory for Non-linear Spectroscopy), Via Carrara 1, 50019 Sesto Fiorentino (FI), Italy

e-mail: miriam.vitiello@sns.it

Recent results on the analysis of the frequency noise features of Terahertz Quantum Cascade Lasers (QCLs) will be discussed, together with their potential in polarization spectroscopy experiments addressed to high sensitivity molecular detection.

Novel nano-technological approaches to surface emission in THz QCLs will be furthermore investigated, underlying the potential of quasi-periodic patterning of the top metal layer of a double-metal waveguide for a collimated high power emission.

A general overview on our novel approaches to Terahertz detection will be finally given by demonstrating antenna-coupled nanowire field effect transistors as plasma-wave THz detectors. Room temperature operation in the 0.3 – 3 THz range is reported with noise equivalent powers as low as a few  $10^{-11}$  W/Hz<sup>1/2</sup>, and high-speed response.



Miriam Serena Vitiello received the Master degree in Physics (cum laude) in 2001 and the PhD Degree in Physics in 2006 from University of Bari. From 2006 to September 2008 she was a Post-Doctoral Research assistant at the University of Bari. From October 2008 to January 2010 she joined the Regional Laboratory LIT<sup>3</sup> of the CNR-INFM as a researcher. Since 2010 she is permanent research scientist at the CNR – Department of Physical Science and Material Technologies and she is actually developing her scientific activity at the NEST Laboratory of the Scuola Normale Superiore in Pisa and the LENS Laboratory in Florence. She is the coordinator of a proposal FIRB-Futuro in Ricerca and the actual Italian Representative within the EU Cost Action in the Terahertz Photonics field and she collaborated as key scientist to several national and international research projects. She was visiting scientist for short research stages at the Technical University of Delft (April 2004-December 2004), at the Technische Universität of Munchen (July 2004) at THALES in Paris (2005) and at the University of Paris VII (2006). Her researches concern the development and the applications of THz quantum cascade lasers; micro-photoluminescence and Raman spectroscopy; the development of THz waveguides; the development of THz

nanostructured detectors based on semiconductor nanowires or graphene; far-infrared metrology; graphene-based photonics devices. Dr. Vitiello is member of the program committee of more than 20 key international conferences in the field of photonic devices. She is co-author of 70 refereed papers on international journals, holds 1 patent and delivered more than 20 invited talks at international conferences. She gives more than 30 lectures at international universities. For her research activity she received the “Sergio Panizza” Prize of the Italian Physical Society (2012), an International Scientific Author Award (USA, 2005) and 2 National Young Author Awards (2003; 2005).