Title: Challenges for the Development of Low-cost Thermal Infrared *'THz Torch'* Spectrometers

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Abstract

Molecules can exhibit strong absorption (vibrational and rotational resonances) in the terahertz spectrum with a unique spectroscopic fingerprint. This enables THz time-domain spectroscopy (THz-TDS) to be widely used for identifying chemical and biological materials of interests non-destructively and non-invasively. However, conventional THz-TDS systems are not robust and very expensive, and may require liquid helium cooling for bolometer detection. Advanced wideband THz-TDS with photoconductive antennas are capable of operation at room temperature, but all measurements have to be performed within a vacuum-tight enclosure, in order to reduce water vapour absorption. A low cost, room temperature and compact thermal infrared *'THz Torch'* spectrometer is currently being developed. Here, a robust statistical technique for material identification uses a comprehensive database of thermal infrared spectral signatures.

The thermal infrared *'THz Torch'* technology was first introduced, in 2011, for short-range secure wireless communications. It fundamentally exploits engineered blackbody radiation, by partitioning thermally-generated spectral power into pre-defined frequency channels; the incoherent energy in each channel is then independently pulsed modulated. The hardware part of the *'THz Torch'* spectrometer consists of a thermal infrared emitter with black body radiation characteristics, 16 pairs of narrow band-pass THz filters, supplied by Northumbria Optical Coating Ltd, a pyroelectric sensor with integrated low noise amplifier and a lock-in amplifier to improve the signal-to-noise ratio. Then the coarse set of 16 discrete spectral data points (transmittance in transmission mode or reflectance in refection mode) for each material under test is correlated against stores signatures using robust statistical technique.

Biography

Dr. Stepan Lucyszyn received the Ph.D. degree in electronic engineering from King's College London (University of London), London, U.K., in 1992, and the D.Sc. (higher doctorate) degree in millimeter-wave and terahertz electronics from Imperial College London, London, U.K., in 2010. He is currently a Reader (Associate Professor) in Millimeter-Wave Electronics and Director of the Centre for Terahertz Science and Engineering, Imperial College London. He was the Chairman of the 41st European Microwave Conference, held in Manchester (UK, 2011) and will Co-chair the 11th European Microwave Integrated Circuits Conference, to be held in London (UK, 2016). Dr Lucyszyn is Fellow of the Institute of Physics (UK, 2005), Institution of Engineering and Technology (UK, 2005), The Electromagnetics Academy (USA, 2008) and Institute of Electrical and Electronic Engineers (USA, 2014). He co-founded the Imperial College London spin-out company Drayson Wireless Ltd, est. Apr. 2014.