Can terahertz spectroscopy become the gold standard of 2D quality control?

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Over the past decade, we demonstrated terahertz spectroscopy to be an efficient tool for fast, non-destructive electrical characterisation of graphene on various substrates [1-4], including silicon, sapphire and polymers. Key parameters such as conductivity, carrier density, carrier mobility and uniformity can be extracted across wafer-scale graphene, and a metrology standard for THz-TDS of graphene was published recently through the International Electrotechnical Commission [3]. Several important questions arise: can THz-QC be applied to roll-2-roll production systems? How reliable and robust is THz-QC, and does it work equally well on all substrates? Will THz-QC be useful for TMDs? For process development? What can we learn about the uniformity and grain structure of 2D films? In this talk I will briefly overview the state-of-the-art and recent progress in THz-based quality control (THz-QC) and address possibilities, problems and open questions related to this emerging technology, and show preliminary results on R2R inline THz-QC, large-scale mapping of TMD films and graphene micro- and nanoribbon gratings.

References

[1] P. Bøggild et al, 2D Materials 4 (2017) 042003
[2] P. W. Whelan et al, 2D Materials 8 (2021) 022003
[3] J. Buron et al, Nano Letters, 12 10 (2012) 5074
[4] J. Buron et al, Nano Letters , 14 (2014) 6348
[5] P. U. Jepsen et al, "Graphene-based material – sheet resistance : terahertz time-domain spectroscopy", IEC TS 62607-6-10:2021 (2021)

Figures

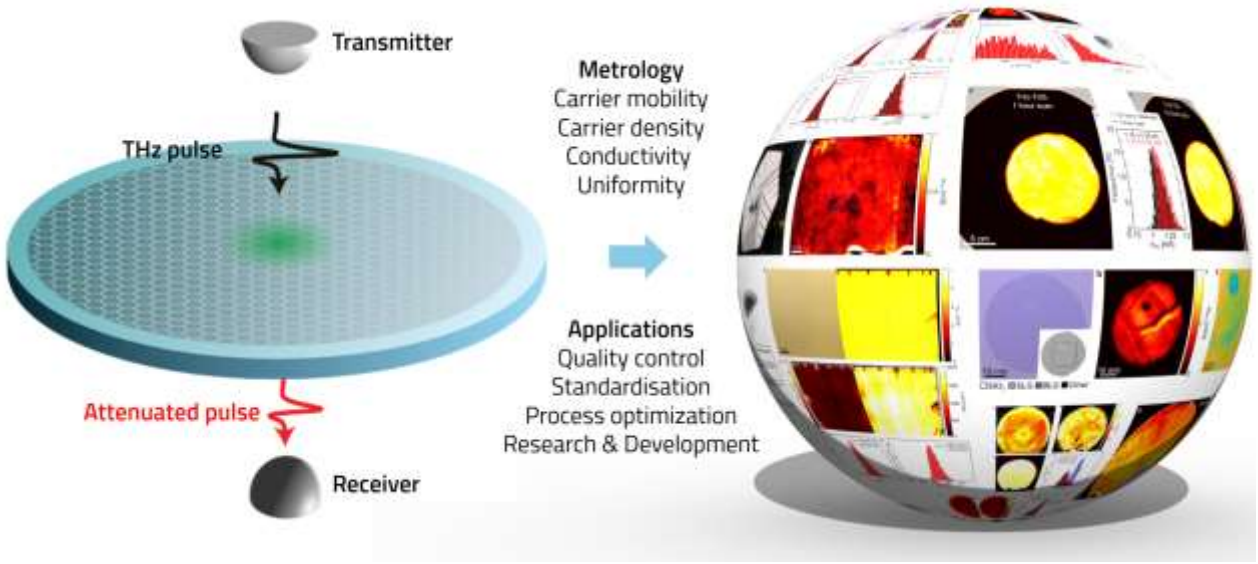

Figure 1: THz time-domain spectroscopy of 2D materials can be used to extract a number of critically important electrical and structural parameters without physical contact or damage, and is a candidate for quality control in 2D large-scale manufacturing.