# Terahertz Spectroscopy for Wireless Electrical Characterization of 2DM

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Over the past decade, we have pioneered terahertz spectroscopy as an efficient tool for fast, non-destructive electrical characterization of graphene on a range of substrates, including silicon, sapphire, and polymers [1–2]. Wafer-scale parameters such as conductivity, carrier density, mobility, and uniformity can be extracted, and a metrology standard for THz-TDS graphene was published through the International Electrotechnical Commission [3]. This progress raises several questions: can THz-based quality control (THz-QC) be applied in roll-to-roll production, how robust is it across different substrates, and can it support process development? What information can THz-QC provide on film uniformity and grain structure [4]? Can it be pushed to the nanoscale? With growing interest in large-scale manufacturing of other 2D materials, such as transition-metal dichalcogenides, how can THz-TDS contribute to their research and quality control? In this talk, I review the state of the art and recent advances in THz-TDS, discuss opportunities and limitations, and present results on inline roll-to-roll THz-TDS, large-area mapping of TMD films [5], graphene micro- and nanoribbon gratings, and recent results in measuring sub 50 nm resolution conductivity using THz scattering SNOM. I conclude by addressing the role of metrology and reproducibility in overcoming challenges in research and technology transfer.

## References

[1] P. Bøggild et al, 2D Materials 4 (2017) 042003
[2] P. W. Whelan et al., 2D Materials 8 (2021) 022003
[3] P. U. Jepsen et al., Graphene-based material – sheet resistance : terahertz time domain spectroscopy, IEC TS 62607-6-10:2021 (2021)
[4] W. W. Whelan et al., Scientific Reports 14 (1) 3163 (2024)
[5] Jie Ji et al, ACS Appl. Mat Int, 15 44 51319 (2023)

## Figures

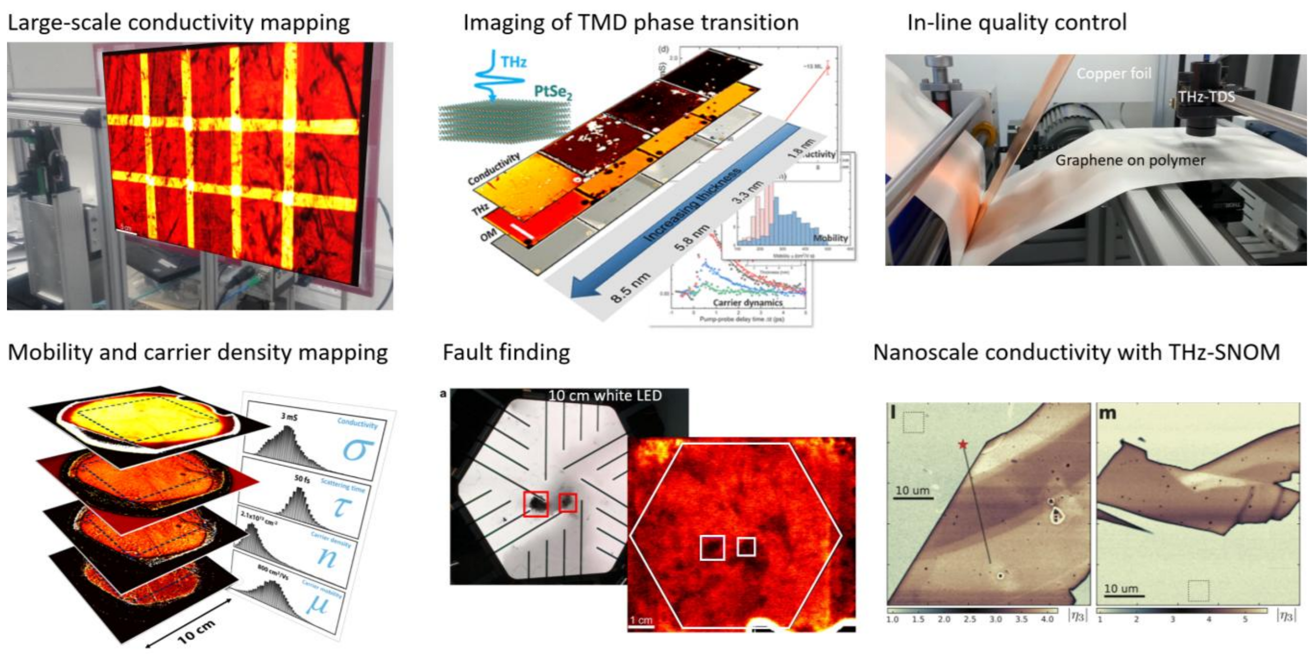


**Figure 1:** The talk will cover different examples of THz-TDS used for quality control, R&D and research.