Towards inline electrical metrology of graphene

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As monolayer graphene films made by CVD growth are becoming available at competitive price point and quality, the list of attractive applications grow within electronics and photonics. There is a strong need for large-scale, non-destructive characterisation techniques as traditional field-effect device are cumbersome and ineffective in providing spatial information on the electric properties on a large scale. While lithographic processing to some extent destroys the fragile graphene film, scanning probes that rely on physical contact with the graphene film also lead to unwanted scratches and contamination. Since the terahertz absorption of graphene is directly linked to its electrical conductivity, terahertz time-domain spectroscopy allows to extract not only the conductivity, but also carrier density, carrier mobility and even Fermi velocity from a graphene film, without physical contact. In the talk, I will overview our efforts towards making THz-TDS a viable metrology technique. In early 2021 we publish an International Electrotechnical Commission (IEC) metrology standard and a comprehensive review article that overviews selected exemplary cases from our numerous collaborations on graphene on polymer substrates, silicon carbide, silicon, and sapphire, as well as encapsulated graphene. I will show how useful insights into the impact of imperfections and non-uniformity on the electrical properties and the spatial uniformity can be extracted from THz-TDS maps. The talk will highlight the strengths and weaknesses of the technique and discuss what is needed to realise high speed inline electrical characterisation in a production environment.

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FIGURES

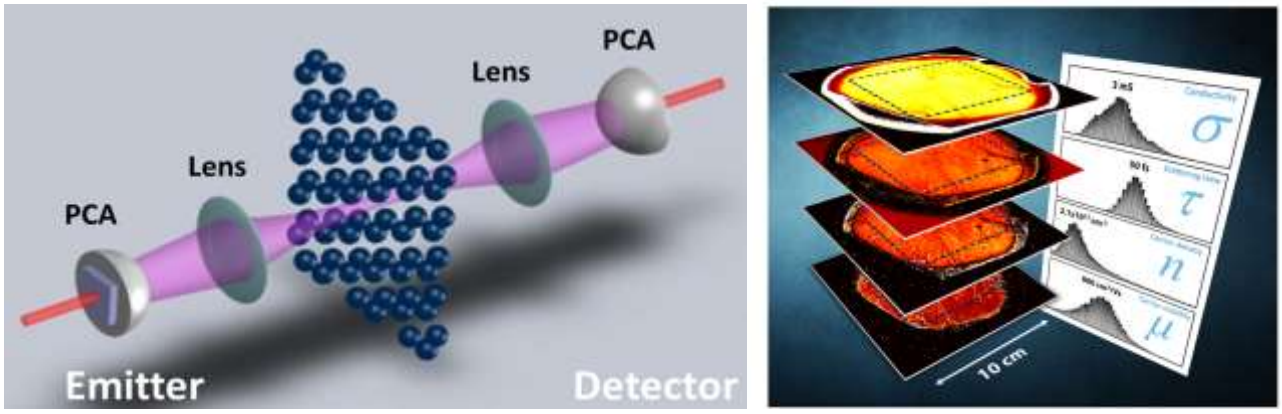

Figure 1: Thz-TDS measures the absorption of terahertz radiation by graphene. From the frequency dependent conductivity, the DC conductivity, scattering time, carrier density and carrier mobility can be extracted.