High-resolution Terahertz near-field inspection for 2D-materials

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For the production and transfer of graphene layers, a variety of tools and techniques are available. Some of them allow high material quality and exact tailoring of specific properties. Non-destructive quality inspection of the produced material is therefore essential for graphene manufacturers to comply with standards – and for device manufacturers to assure high fabrication yields. A highly versatile approach for the non-destructive, quantitative characterization of conductive thin-films, including 2D-materials such as graphene, is based on terahertz (THz) time-domain spectroscopy (TDS) transmission measurements [1].
The application of near-field techniques further increases the potential due to an improved spatial resolution that enables the detection of micron-scale defects and local inhomogeneities in charge-carrier properties of the material. The key-enabling technology for high-resolution THz imaging are photoconductive THz near-field microprobes [2]. Applied for THz transmission measurements at graphene, the outcomes include spatially resolved conductivity and mobility information. Exemplary results are plotted in figure 1: a) shows the THz near-field microprobe in the imaging setup. b) and c) display the obtained THz time-domain and spectral data that allow the extraction of frequency-resolved charge carrier properties. Conductivity results for a 4" graphene layer on a 6" silicon substrate wafer are plotted in fig.1 d) and e), enabling the identification of large-scale inhomogeneities as well as ruptures and microscopic cracks that were introduced during a transfer step.
Recently, we applied high-resolution THz near-field transceiver probe-tips for the inspection of graphene-layers in reflection-mode (instead of transmission-measurements). By taking advantage of the additional interface-selectivity, we can now directly discern substrate- from top-layer inhomogeneity, which is important for the reliable 2D-layer characterization on inhomogeneous substrates.
Graphene manufacturers and researchers can directly benefit from recent developments by the integration of TeraSpike microprobe detectors into existing THz-TDS setups, by the acquisition of complete THz near-field imaging systems or by custom inspection runs in our characterization systems. We gratefully acknowledge funding by the German BMBF in the framework of the GIMMIK project 03XP0210.

References

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Figures

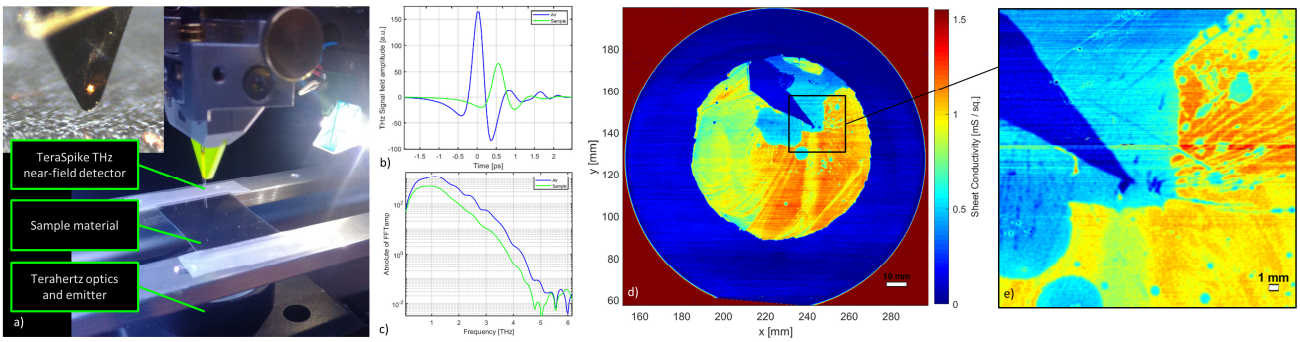

Figure 1: Terahertz near-field setup (a) together with typical THz transients (b) and spectral data (c). Results of conductivity measurements for a 4" graphene layer on a 6" silicon substrate (d and e).