# Wafer-scale inspection of graphene conductivity by THz near-field scanning: As-grown on sapphire and after transfer to $SiO_2$/Si

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Various methods for wafer-scale graphene production are currently developed, however powerful inspection tools to monitor graphene quality are rare. Raman inspection is a widely accepted method, but usually does not yield quantitative values for graphene conductivity. With more destructive methods like contact-based 4pp measurements or using specifically manufactured devices, the electronic properties of graphene are quantitatively measurable. Terahertz (THz) transmission spectroscopy is emerging as graphene inspection method, that allows graphene conductivity and mobility measurements without the need to destroy or even touch the graphene layer [1]. Here we apply high-resolution THz near-field inspection [2] for locally resolved graphene conductivity measurements at complete wafers. Fig. 1a) shows THz conductivity measurement results for a 2" graphene sheet directly on the sapphire substrate, as grown by AIXTRON. Fig. 1b) shows THz inspection results with 80µm resolution of the same graphene, but after transferring the layer to a $SiO_2$/Si substrate. The results show that basically the complete 2" layer is transferred. After transfer the higher conductivity at the sample border as visible in (a) has vanished. Instead, some smaller defects and two larger regions of decreased conductivity can be identified, that were induced during the transfer. The conductivity histograms refer only to the circled, central graphene regions and indicate stable conductivity around 1.2-1.5 mS/sq. with a slight increase after transfer. The presented results demonstrate how THz inspection can be used to monitor the electronic properties of graphene on different substrates without the need to touch the graphene or fabricate devices. We gratefully acknowledge funding by the German BMBF (project GIMMIK, 03XP0210).

References

[1] J. D. Buron et al., Scientific Reports 2015, vol. 5, p. 12305
[2] M. Wächter et al., Applied Physics Letters 2009, vol. 95, no. 4, p. 041112

Figures

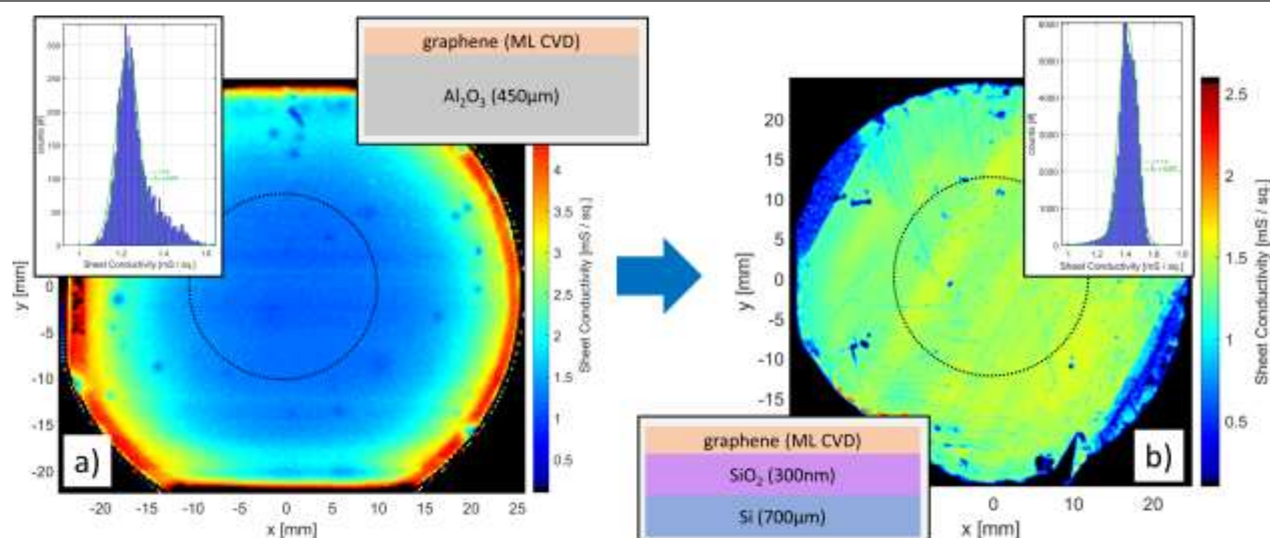


**Fig.1:** Graphene conductivity measured with THz near-field transmission spectroscopy. a) Conductivity of a CVD-grown graphene mono-layer, still on 2" sapphire growth substrate. b) Measurement at the same graphene sheet after it has been transferred onto a $SiO_2$/Si wafer. The insets show the material stacks and the graphene conductivity distribution respectively.