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Large area THz mapping of electrically controlled graphene conductance

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We demonstrate non-contact, mapping of gate-controlled conductance of single layer graphene films by terahertz time-domain spectroscopy (THz-TDS). The applied technique measures the broadband, frequency-resolved sheet conductance of graphene films in the region from approx. 0.1-2 THz modulated by an electrostatic back-gate, and thus facilitates non-contact and spatially resolved characterization of conductance, carrier mobility, carrier density, carrier scattering rate, and chemical/substrate doping level at a fast acquisition rate for large area graphene films.

It has been shown recently that the intraband dominated THz response of CVD graphene films can be controlled by an electrostatic

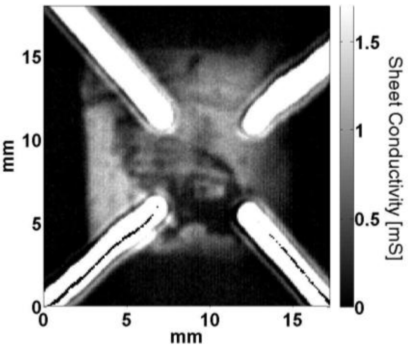

Fig. 1 THz graphene conductance image with back-gate. Frequency range is 1.0-1.1 THz. Gate-voltage is 0 V

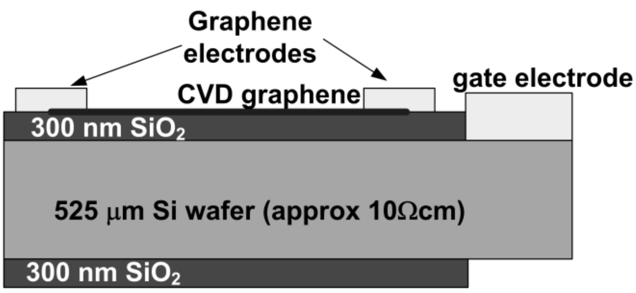

Fig. 2 Substrate design used for electrostatically controlled graphene THz conductance mapping.

signal applied to a semi-transparent silicon back-gate, also serving as substrate [1],[2]. Here we extend the approach, by demonstrating spatially resolved, gate-controlled, broadband THz conductance mapping of large area graphene films with high contrast, pronounced gate-modulation and high acquisition rates, as shown in fig. 1. A ρ=10 Ωcm, semi-THz-transparent silicon substrate covered with 300 nm SiO_2 serves as electrostatic back-gate for Fermi level control in the graphene film. THz mappings are compared with supporting μ-Raman mapping to allow insight into correlations between large-area variations in THz electronic properties and μ-Raman signal.

Because of its non-contact nature and high acquisition rate, we propose that the technique is highly suited for direct, quantitative mapping of important properties such as carrier mobility, carrier density, substrate/chemical doping level, and scattering rate of large area CVD graphene films in the industry.

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