Large-area conductivity mapping of graphene on polymer films by THz time-domain spectroscopy

Patrick R. Whelan[1], Deping Huang[2], David M. A. Mackenzie[1], Sara A. Messina[1], Zhancheng Li[2], Xin Li[2], Yunqing Li[2], Timothy J. Booth[1], Peter U. Jepsen[1,3], Haofei Shi[2], and Peter Bøggild[1]

[1]*Center for Nanostructured Graphene (CNG), Technical University of Denmark, Denmark*
[2]*Chongqing Institute of Green and Intelligent Technology, Chinese Academy of Sciences, P. R. China*
[3]*DTU Fotonik, Technical University of Denmark, Denmark*

patwhe@nanotech.dtu.dk

Rapid inline monitoring of the electrical homogeneity of graphene on polymer substrates is an essential requirement for quality control in industrial graphene production. We present results on accurate measurements of the sheet conductivity of graphene on polymer films by terahertz time-domain spectroscopy (THz-TDS) – a non-destructive and non-contact method that has until now mainly been used to measure the electrical properties of graphene on oxidized silicon [1]. THz-TDS maps of 25x30 cm^2 area graphene on PET were recorded and the DC conductivity was extracted from the measurements (Fig 1a,b). The conductivity of graphene on PET measured by THz-TDS is comparable to values obtained from four point probe (4pp) measurements (Fig 1c). Additionally, the THz-TDS conductivity maps highlight defects such as tears and holes in the graphene film, which are not easily visible to an optical inspection (Fig 1d).

This extends the application range for non-contact conductivity mapping, and provides a strong starting point for systematic optimization and fast inline characterization of large-area graphene for flexible devices.

We will further highlight other application scenarios for THz-TDs measurements of graphene.

Figure

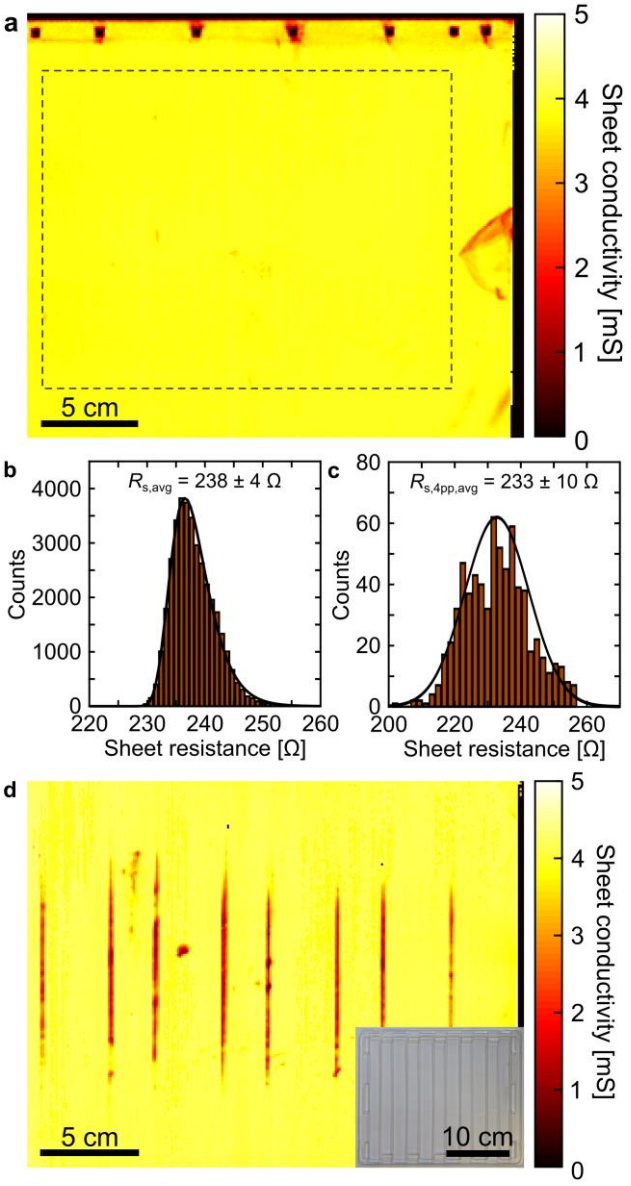

Figure 1: (a) THz-TDS sheet conductivity map of a 25x30 cm^2 graphene on PET sample. Dashed square highlights 215x171 measurement points used for extracting sheet resistance. (b) Histogram of sheet resistance with a fitted GEV distribution. (c) Sheet resistance histogram with a fitted normal distribution of 690 points measured by 4pp on a 25x30 cm^2 sample similar to the one shown in (a). (d) THz-TDS sheet conductivity map for a 25x30 cm^2 graphene on PET sample that has been damaged during transport. The bottom right inset shows a photograph of the box used for packaging with indentations for holding the sample.

Reference

[1] P. Bøggild *et al.*, 2D Materials, 4 (2017), 042003