A novel and fast route to reduce Graphene oxide thin-film on wafer-scale

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A spin-coating process to create graphene oxide (GO) thin films with precise thickness control over silicon and glass wafer was successfully established. A suitable reduction treatment transformed GO into reduced graphene oxide (rGO), which serve as highly sensitive bipolar transducer layers in the biosensing field.

As a starting material we optimized the exfoliation synthesis. To reach a reliable quality of GO as a nanomaterial source for the spin coating, the temperature parameter during synthesis was lowered and additional purification steps were added. The spin-coating on pre-treated wafers with uniform siloxane layers enabled us to generate homogeneous GO films on wafer-scale. Subsequently, the GO were structured into micro- and nanoscale patterns by standard photolithography or nano-imprint pattering.

Towards process integration of the GO, a novel and fast reduction method was realized by Rapid Thermal Processing (RTP). The evolution of the reduction process was confirmed by Raman characterization Fig.1). The I-V measurements in Fig 2.a) showed that the sheet resistance of the rGO on interdigitated microelectrodes was in the range of 3-40 kΩ after RTP reduction treatment for 2s. The bipolar field-effect in Fig 2.b) illustrate the Dirac point between -0.1 V and 0 V. The position of the characteristic curve shows an n-type behave which was induced only by the reduction temperature at 350°C.

References

[1] *Lu & Munief*, Front-End-of-Line Integration of Graphene Oxide for Graphene-Based Electrical Platforms. Advanced Material Technologies. 1700318, (2018).

Figures

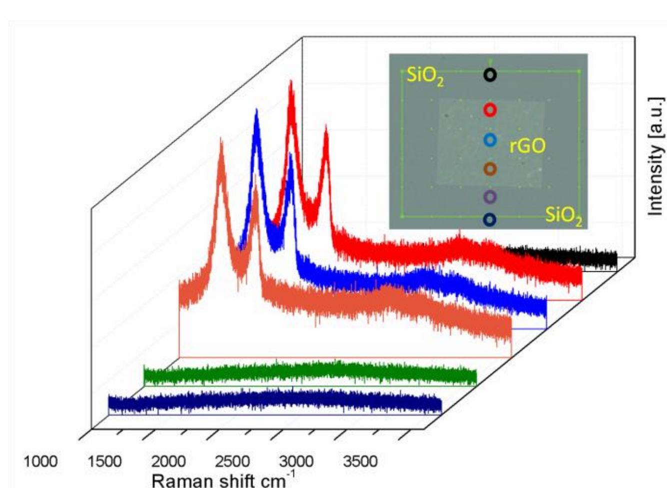

Figure 1: The mapping technique combined with the Raman spectroscopy allows a precise determination of the coated and structured 1-2 nm thick GO layer.

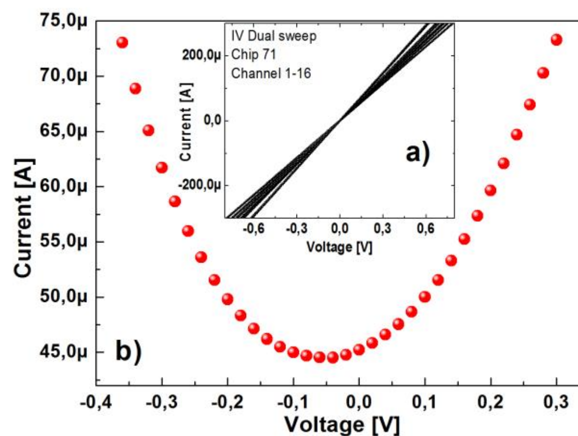

Figure 2: a) The I-V proves the ohmic contact of the rGO thin film and the IDE after RTP reduction. b) In DC-mode the characteristic bipolar function of rGO ISFET in 10 mM PBS buffer.

Towards process integration of the GO, a novel and fast reduction method was realized by Rapid Thermal Processing (RTP). Controlled process time for thermal reduction in combination with a fast annealing step as well as selectable temperature regimes were identified as the key factors to minimize the electrical variation and the sheet resistance for the rGO coating.