A transfer-free approach to wafer-scale graphene deposited by chemical vapour deposition

Vollebregt, Sten; Ricciardella, Filiberto; Romijn, Joost; Singh, Manvika; Shi, Shengtai; Sarro, Lina

Publication date
2018

Document Version
Final published version

Citation (APA)
Vollebregt, S., Ricciardella, F., Romijn, J., Singh, M., Shi, S., & Sarro, L. (2018). *A transfer-free approach to wafer-scale graphene deposited by chemical vapour deposition*. 1-1. Abstract from Graphene 2018, Dresden, Germany.

A transfer-free approach to wafer-scale graphene deposited by chemical vapour deposition

Sten Vollebregt
Filiberto Ricciardella, Joost Romijn, Manvika Singh, Shengtai Shi, Lina Sarro

Delft University of Technology, Department of Microelectronics, Feldmannweg 17, 2628CT, Delft, The Netherlands

s.vollebregt@tudelft.nl

Graphene has several unique properties which make it an attractive material for sensors, optoelectronics, or as nano/micro-electro-mechanical systems (NEMS/MEMS). To allow integration into semiconductor technology, graphene deposited by chemical vapour deposition (CVD) on a metal catalyst is widely regarded as the most promising wafer-scale method.

A downside of CVD graphene is that it requires the transfer of the graphene from the Cu, Ni, or Pt catalyst; a process which introduces polymer contamination, cracks, wrinkles and adhesion issues with the target substrate, therefore reducing yield [1]. While significant progress has been made in graphene transfer [2], there still does not exist an ideal recyclable growth template and repeatable transfer method.

In this work, we present a transfer-free alternative based on Mo as catalyst which can circumvent the issues involved with the transfer. The key to this technology is the pre-patterning of the Mo catalyst layer by photolithography, as shown in fig. 1. This enables selective graphene deposition with high accuracy directly on the substrate.

Using this approach, we have demonstrated high yield (up to 97 %) multi-layer graphene chemristors [3]. Furthermore, we recently extended the process to allow for the fabrication of suspended graphene structures (fig. 2), resulting in the first graphene-based Pirani pressure sensor [4].

While deposition of the graphene directly on the device substrate imposes a high thermal budget which makes integration with already fully-fabricated CMOS devices impossible, this transfer-free approach can be employed when the graphene device and the electronics are separated into two different chips; an approach very common in modern integrated smart sensors.

References

[1] S. Wagner et al., Micrielectron. Eng., 159 (2016) 108-113
[2] K. Verguts et al., ACS Appl. Mater. Interfaces, 9 (2017), 37484-37492
[3] S. Vollebregt et al., Proc. of IEEE MEMS (2016), 17-20
[4] J. Romijn et al., Proc. of IEEE NEMS (2018)

Figures

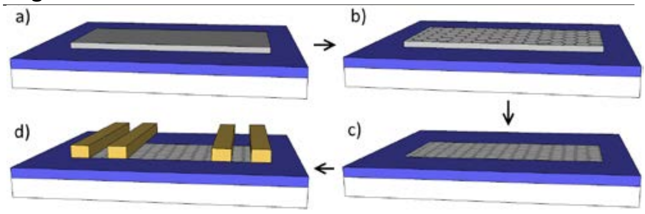

Figure 1: Transfer-free graphene process: a) Mo deposition and dry etching, b) selective CVD deposition of multi-layer graphene, c) wet etching of Mo catalyst, d) Cr/Au metal contact deposition using a lift-off method.

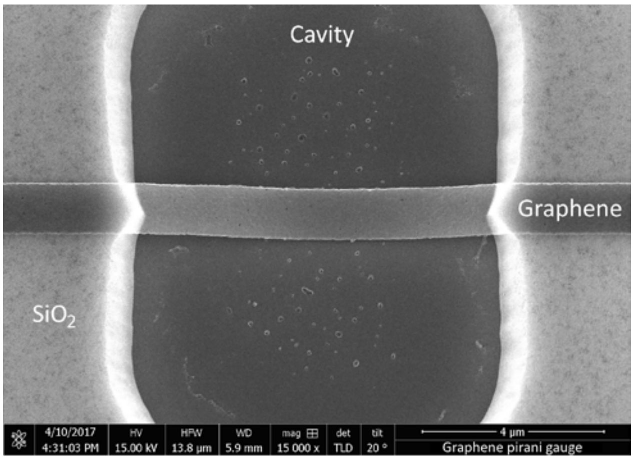

Figure 2: SEM image of a transfer-free suspended multi-layer graphene-based Pirani pressure sensor. The graphene bridge is 1 µm wide, while the SiO_2 is 600 nm thick.