High-yield production and characterization of graphene-based chemiresistors for environmental sensing

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With the growing awareness towards the necessity of protecting the environment, the demand on techniques for real-time detecting and monitoring different hazardous gases has increased notably. In this regard, solid-state gas sensors, due to their small sizes, high sensitivities towards a wide range of gases, and their low cost, offer advantages over other techniques and are therefore regarded as the best candidates for the development of commercial gas sensors [1]. Among different options, graphene-based materials – especially under the architectural configuration of a chemiresistor, i.e. where the gas adsorption is quantified through a measurement of resistance variation – have aroused great interest due to their atom-thick, 2D-nature and its diverse striking properties. A large area to volume ratio, detectable single-atom interaction with gas adsorbates, tunability of sensitivity via functionalization, as well as low-cost and high-scale fabrication by chemical methods constitute some of the most noteworthy advantages of the use of graphene for environmental sensing [2].

In this sense, a crucial aspect in the fulfillment of a high-yield production is the material deposition technique. Here, inkjet printing has proven promising since it enables the large area fabrication of different components on different substrates by a simple, controlled, high-scalable, and versatile process [3]. By means of inkjet printing liquid phase materials mostly consisting of a dissolved solute are deposited onto a substrate. The printing process comprises the droplet ejection from the ink supply through a nozzle, the deposition and spreading of the ink on the substrate, as well as its drying in order to ultimately produce a solid deposit [4].

In spite of all the advantages, inkjet printing of graphene-based inks goes along with multiple difficulties which need to be addressed, being the ink selection and its performance the most relevant one. Furthermore, due to the device's solely resistive nature, the extraction of as much information as possible out of relatively simple resistance measurements is vital. In the current presentation, we will give an overview of inkjet-printed graphene-based chemiresistors at Infineon and also provide an insight in the characterization of the printing process as well as the ink performance.

References

[1] S. Capone, A. Forleo, L. Francioso, R. Rella, P. Siciliano, J. Spadavecchia, D. Presicce,and A. Taurino, "Solid state gas sensors: state of the art and future activities," Journal of Optoelectronics and Advanced Materials 5, 1335–1348 (2003).
[2] W. Yuan and G. Shi, "Graphene-based gas sensors," Journal of Materials Chemistry A1, 10078–10091 (2013).
[3] F. Torrisi, T. Hasan, W. Wu, Z. Sun, A. Lombardo, T. S. Kulmala, G.-W. Hsieh, S. Jung, F. Bonaccorso, P. J. Paul et al., "Inkjet-printed graphene electronics," ACS nano 6, 2992–3006 (2012).
[4] M. Singh, H. M. Haverinen, P. Dhagat, and G. E. Jabbour, "Inkjet printing—process and its applications," Advanced materials 22, 673–685 (2010).