Summary

In this work, we presented inkjet-printed gas sensor fabricated on polyimide film, using Silver nanoparticles as eletrcodes and graphene/PEDOT:PSS mixture as sensing materials. The printed sensors demonstrate high sensitivity to gases such as NH_3 with a the limit of detection of 360 ppb.

Content

Sensing technologies are essential to future intelligent systems, fueled by IoT and connected automation. Gas sensors, which detect trace gases,[1] are particularly impactful with the use of nanostructured 2D materials offering high surface-to-volume ratios, excellent electron transport, and tunable chemistry for sensitivity and portability.[2] Advances in printed electronics have transformed gas sensor fabrication, enabling microscale features, minimal waste, and integration of diverse materials on a single substrate. Among these techniques, inkjet printing has emerged as a promising alternative to traditional methods like UV-lithography, allowing the creation of highly functional, cost-effective devices suitable for various applications.[3]

In this work we present a gas sensor fabricated by inkjet printing technology on polyimide film, employing graphene/PEDOT:PSS mixture as sensing materials and silver nanoparticles as electrodes, This work is the introduction of further studies using other novel 2D materials, such as MXenes and phosphorene, which allow the introduction of more modifications that enhance the functionality and selectivity of the gas sensor.

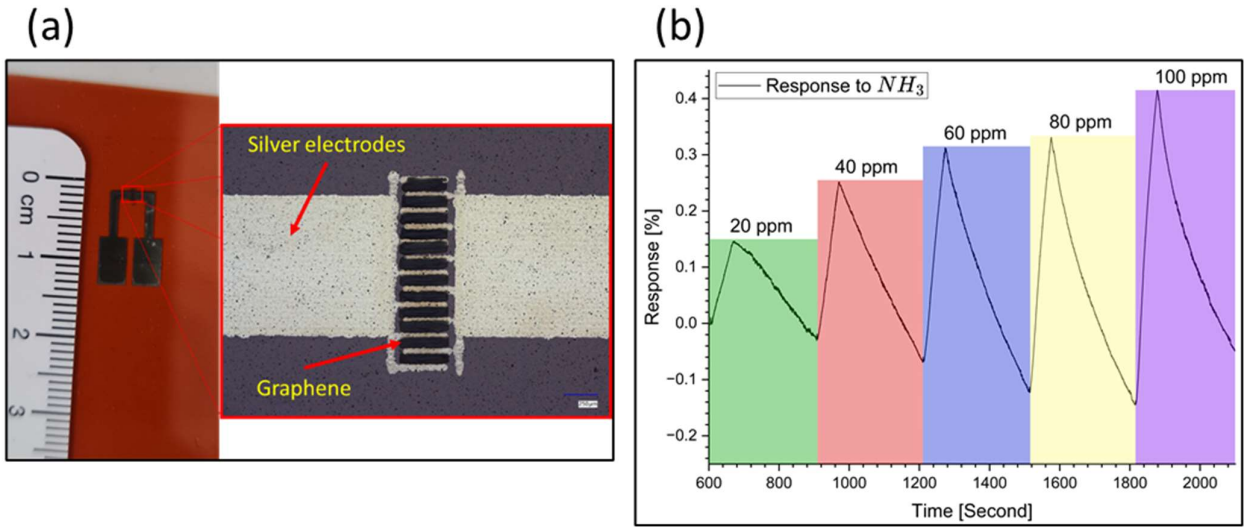

Figure 1.(a) Magnified image of a fully printed graphene/PEDOT: PSS based gas sensor. (b) Response of the printed gas sensor to different concentrations of ammonia.

In Figure 1 , we demonstrate a fully printed gas sensor comprising of two layers, interdigitated electrode (IDE) layer printed with nano-silver particles ink, where the average gap between the pins of the electrodes is ~30 µm, and sensing material layer printed inside the gaps between the pins of the electrodes with a mixture of Graphene and PEDOT:PSS.

The printed sensor has showed an excellent response to NH_3 and at low concentrations, even below the sub ppm level. The results of exposure of the sensor to ammonia is shown in Figure 1. The experiment was done by washing the sensor for 10 minutes with N_2 then exposing the sensor to the analyte gas for 1 minute followed by 4 minutes of washing, and increasing the concentration in each following cycle, the used concentrations were from 20 to 100 ppm. The response of the sensor to these different concentrations was used to calculate the limit of detection (LOD) which was 360 ppb towards ammonia. This value shows that the sensor is able to detect ammonia at levels close to the Typical breath levels that range between 29 and 688 ppb with average of 265 ppb,[4] showing a potential to use the sensor for detection of various biomarkers in the human breath and possibly to detect various biomarkers related to diseases using only the breath.

References

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