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Materials Integration and Novel Device Applications using the Silicon Photonics Integrated Circuit

Iain F. Crowe

Photon Science Institute and Department of Electrical and Electronic Engineering, University of Manchester, Manchester, United Kingdom

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As part of the bio-photonics research theme in the Photon Science Institute at the University of Manchester, we are looking at ways in which the functionality of miniature, chip-based silicon photonic integrated circuits (PICs), more traditionally targeting telecoms applications, can be extended into the arena of accurate, cost effective bio-medical and environmental sensors. The potential of mass-scaled (and thus cost-effective) devices developed within the silicon CMOS fabrication process, significantly improves the prospect of being able to deliver improvements in e.g. healthcare *via* sophisticated, yet inexpensive technologies. This talk will highlight a specific example of our recent work to develop a sub-micron-scale, waveguide based silicon PIC capable of detecting vapour phase volatile organic compounds (VOCs) e.g. as disease markers in exhaled breath, or for identification of the presence of industrial pollutants.

The optical response of the device to a range of vapour phase VOCs is improved considerably by integration of a graphene oxide (GO) layer. Simulations reveal that the strength of this optical response is determined by molecular specific changes in the local refractive index, probed by the evanescent field of the guided optical mode in the device. Analytical modelling of the experimental data, based on *Hill-Langmuir* adsorption characteristics, suggests that these changes are determined by the degree of molecular cooperativity, which is enhanced for molecules with a polarity that is high, relative to their kinetic diameter. This reflects a molecular dependent capillary condensation within the GO interlayers, which, when combined with highly sensitive optical detection, provides a potential route for discriminating between different VOCs.