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Towards an 'optoelectronic nose': Metal phthalocyanine modified siloxane polymers as sensing elements for volatile organic compounds

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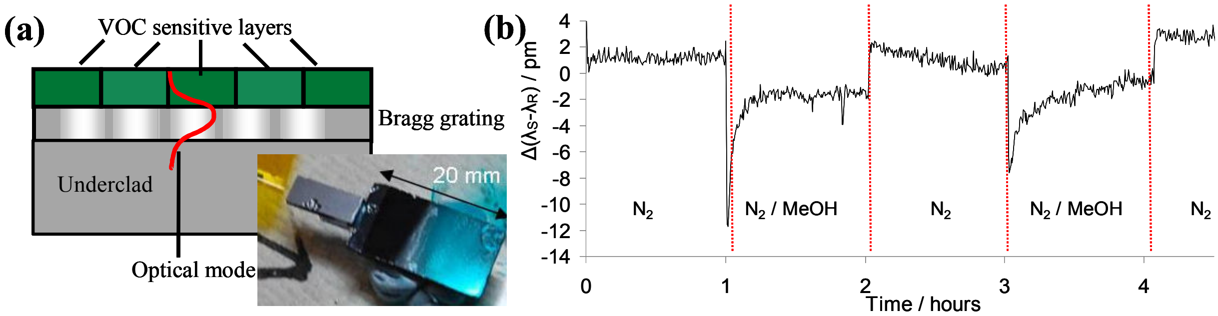
Sensing of volatile organic compounds (VOCs) such as alcohols, ketones and amines is required within a diverse set of fields including industrial chemical processes, environmental monitoring/clean-up operations and homeland security. The sensing of VOCs can be achieved through the use of both electronic sensors and optical sensors. Optical sensors demonstrate many benefits over electronic sensors, including remote interrogation of large arrays via optical fibre over many tens or hundreds of kilometres, immunity to electromagnetic interference and most importantly the absence of spark risk in flammable environments[1].

Optical waveguides can be written with a UV-laser into a photosensitive planar glass layer to produce a wide range of optical devices. Bragg gratings can also be fabricated within the waveguides; these components reflect at one wavelength of light and transmit all others[2]. The wavelength reflected by a Bragg grating is dependent on the refractive index of the material the light is exposed to. It has been previously shown that a planar optical waveguide containing a Bragg grating is an effective method of detecting minute changes in refractive index[3]. The evanescent field of the optical mode within an unclad waveguide containing a Bragg grating interacts with chemical receptors on the surface of the sensor. This device works by detecting the associated effective refractive index change when the receptor binds to a chemical analyte. The change in effective index is directly proportional to the Bragg wavelength of the grating. Accurate spectral measurement provides high dynamic range with observable changes in the effective refractive index of 10^{-6}. This work looks at depositing metal phthalocyanine functionalised siloxane polymers in strips on the surface of these sensors for detection of VOCs, shown in Figure **(a)**.



(a) Schematic of the proposed 'optoelectronic nose' and a photograph of the polymer-coated Bragg sensor device

(b) The response of this Bragg sensor to changes in the concentration of methanol vapour in a flow of dry nitrogen gas.

Phthalocyanines are intensely coloured macrocycles that can coordinate more than 70 of the elements in the Periodic Table. Metal phthalocyanines have been demonstrated in the literature as active sensing elements for detection of VOCs[4]. Zinc phthalocyanine in particular has an affinity for alcohols, ketones and carboxylic acids[5]. Here we shall present developments on the synthesis of a siloxane polymer modified with zinc phthalocyanine and the fabrication of the device (shown inset Figure **(a)**) to enable sensing of alcohols. Preliminary results for the sensing of methanol using this device is shown in Figure **(b)**. After the removal of temperature effects via a reference grating, a clear step-wise reduction in Bragg wavelength is observed upon exposing the device to a flow of methanol-vapour rich nitrogen gas compared to dry nitrogen gas. Synthesis, fabrication and the latest sensing results will be presented.

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