Detecting oil seeps in seawater, sensing bacteria in milk, and identifying disease states from a patient's urine: New applications for gold nanoparticle chemiresistors

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Abstract

Thiol-functionalised gold nanoparticle (Au_{NP}) chemiresistors have been shown to respond to low-molecular weight chemicals through changes in electrical resistance. They can be fabricated by depositing gold nanoparticles onto microelectrodes, as illustrated in Figure 1. Au_{NP} chemiresistors have mainly been used to detect chemicals in the gas phase but we have shown that they can also be used to detect low-molecular weight molecules in liquids [1] and we have characterised some of the properties relating to this new area of testing [2].

Building on this advancement, we have investigated several applications for the chemiresistor technology in liquid environments. An array of different thiol-functionalised Au_{NP} chemiresistors has successfully detected and discriminated hydrocarbon fuels, such as crude oil, diesel and gasoline, in artificial seawater [3]. Such an application could generate millions of dollars by improving the prospecting process for oil in seawater. We have also demonstrated that Au_{NP} chemiresistor devices will operate in biological fluids in combination with ultrafiltration membranes [4]. This work showed that an array of Au_{NP} chemiresistors could detect the spoilage of milk in accordance with industry standard methods. A quick and easy screening method in the food and drink industry could help prevent the spread of food borne illnesses. We are now investigating chemiresistor sensor arrays for the diagnosis of disease. In this work our chemiresistors have detected known tuberculosis biomarkers in the low parts per billion range in synthetic urine. Chemiresistors have the potential to be developed into an inexpensive, easy to use and portable diagnostic device which could be utilized in developing countries to diagnose diseases such as tuberculosis and malaria and as such could have a dramatic impact on saving lives.

Au_{NP} chemiresistors are emerging as potential technologies for applications in environmental monitoring, food quality control and medical device diagnostics and are continuing to advance into new areas. The performance of chemiresistors combined with their simplicity and low costs make the technology an appealing and exciting alternative to existing methods for small molecule detection in solution.

References

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[4] L. J. Hubble, E. Chow, J. S. Cooper, M. S. Webster, K.-H. Müller, L. Wieczorek, B. Raguse, Lab on a Chip, (2012) DOI:10.1039/C2LC40575J.

Figures

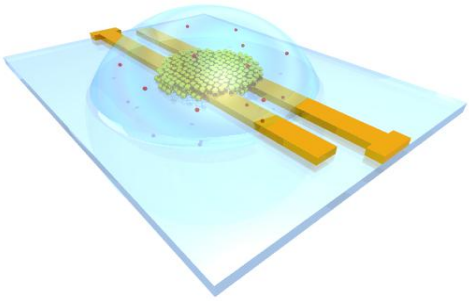

Figure 1. Illustration of a gold nanoparticle chemiresistor consisting of gold nanoparticles deposited onto electrodes. Solutions containing analytes of interest can be exposed to the chemiresistor for testing.