electronic conductivity (and an increase in mass) was measured as the organic content increased. The change in conductivity can be attributed to swelling that occurs as the organic vapours or solvents partition into the network, resulting in an increase in the average distance between gold nanoparticles and therefore less efficient electron tunnelling.

Swelling mechanisms have been used previously for sensing[4–8]. In most of this work, vapours partition into polymers and cause either an optical, electrical or mass change in the sensing material. Arrays of such sensors containing different polymers can be prepared, and the overall response profile of the array used in conjunction with pattern-recognition algorithms. Such systems have been referred to as "electronic noses" or "artificial noses" because their operating principle parallels that of the olfactory system[9,10]. The present study is the first to use MPC films as vapour sensors. One advantage of these films is that the distances between the nanoparticles can be varied in a systematic way, thereby allowing greater control over the system design and its resulting response.

The MPC devices can convert the vapour signal into three of the four basic mechanisms of sensor transduction, a unique aspect of this new class of sensors. The authors demonstrate a change in electrical properties by measuring conductivity, a change in optical properties by measuring the surface plasmon intensity, and a mass change by assembling the film on a quartz crystal microbalance. The ability to integrate multiple signals from a multitude of transducers makes this approach a potentially powerful one and is a step towards integrated sensors with more robust and diverse responses. Furthermore, the ability to readily modify the films in a combinatorial fashion should make preparing arrays that discriminate between different analytes much easier.

In contrast to most sensors, the present paper describes a chemically designed system in which the components are assembled in a hierarchical fashion. Directed assembly of the nanoscale materials occurs on a modified substrate to form a thin micrometre-scale layer of sensing material. Moreover, the entire device functions at the macroscopic level to provide a measurable signal. One of the least-discussed aspects of nanotechnology is the requirement to connect the system to the macroscopic world. Wiring devices to the outside world for power and for input/output is essential for any new material to serve a useful function. By combining both bottom-up and top-down assembly in one device, Murray and colleagues have created a functional sensor that can provide useful measurements.

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MATERIAL WITNESS

Encounters of the literary kind

There was an element of Pasteur's dictum about luck and preparedness in the way I acquired a copy of David Fishlock's 1967 book *The New Materials* (John Murray, London) a year ago. It was lying in a waste pile awaiting collection outside a house near mine, and the word 'materials' sprung out at me.

I was delighted to find a book that mirrors exactly what I was trying to do 30 years later in my own book, *Made To Measure*: to convey to a non-scientific audience why, as David puts it, "the pace at which a technology advances depends upon engineers having the materials with which to change scientific discovery or ingenious invention into practical technology". Several of his chapters isolate the same topics as I did: "optical materials", "living materials", "materials with holes", "materials with memories".

It is to my discredit that I did not then know the author of *The New Materials*, but that has since changed. In the 1960s David was technology editor for *New Scientist* magazine, and he is still writing about engineering and industry today. Recently, I spoke to him about his experience of writing a book on materials science nearly four decades ago.

Then, as now, any emerging technology stimulated a burst of materials innovation because it inevitably needed substances that did not exist. Whereas today information technology is arguably the key driving force in the development of advanced materials, in the 1960s it was aerospace and nuclear engineering that alerted David to the importance of materials science.

"One of the strong influences was Harwell [the UK's centre for atomic-energy research]", he told me. Harwell's materials initiative was dedicated largely to solving the metallurgical problems of reactor design. The need for improved alloys in aerospace, meanwhile, led to the development of the first nickel-based superalloys.

So metallurgy ruled the roost. Polymer science was embryonic; ICI established its polymers laboratory at Runcorn only in the 1960s. One of the highlights of *The New Materials* was the discussion of artificial organs and biomedical implants — a development that inspired David to write the equally prescient *Man Modified* in the late 1960s, a look at how materials science was entering medicine.

But I was most astounded by a sentence in the book's introduction: "These studies have brought us to the verge of a technology we might well call 'molecular engineering': the practice of creating a material having exactly those properties the designer requires". I had proudly paraded this as a central message of *Made To Measure*; it was humbling to find it foreseen long ago.

What David had in mind were techniques such as thin-film deposition for semiconductors, pioneered by Leo Esaki and others. Organic and bio-inspired materials, self-assembly methods and atomic manipulation had not yet blossomed. But there is almost something liberating, for those of us who write about science, in discovering that whatever we say has probably been said before.

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