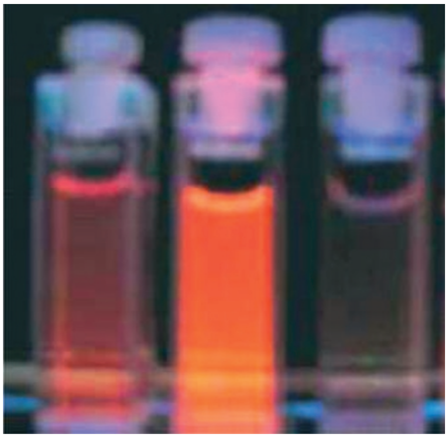

Figure 1 | A versatile molecular sensor. Schmittel and Lin[1] have prepared a luminescent compound that identifies different kinds of metal ion. The left-hand vial contains a solution of this compound. The intensity of its luminescence increases on the addition of lead ions (middle vial), but decreases in the presence of copper ions (right-hand vial). The ion sensor also has three other ways of distinguishing between ions. (Reproduced from ref. 1.)

The three channels mentioned above have previously been used together in various combinations[5], but Schmittel and Lin[1] now cleverly build on this foundation by adding the rarely used sensory technique of electro-generated chemiluminescence[6]. This detects light emission from molecules following their electrochemical oxidation or reduction, and is therefore conceptually related to the other three methods.

The authors' sensor molecule is based on two components — an optical unit that can generate signals for all four channels, and a metal-binding receptor unit, which also contributes to redox activity. The optical unit is a luminescent ruthenium complex that hails from a family of compounds commonly used in some types of solar cell[7]. The receptor unit is an aza-crown ether[8] — a molecular loop that forms a three-dimensional crown shape in solution — that can encircle and ensnare metal ions.

The aza-crown ether is jostled by the chemical groups that surround the ruthenium centre, so that the receptor binds preferentially to different metals depending on the sensory technique used. This is because each method of detection deposits different net amounts of electric charge on the receptor. The sensor attempts to stabilize this charge by overlapping the molecular orbitals of the receptor with those of the optical unit, but the movement involved in this process is restricted by the jostling chemical groups. The amount of movement that occurs ultimately depends on the amount of charge on the receptor. As a result, the receptor is compressed to various extents depending on the sensory technique used, which in turn determines which metals fit into the receptor. Such multi-exploitation of a single kind of receptor is particularly clever — previously, sensors designed to handle several kinds of ion required a selective receptor for each of their targets[9].

As with any advance, this work suggests many possibilities for future studies. For most practical applications, the sensor must be adapted to measure ion concentrations in water, rather than in the organic solvents used here. The broad utility of this approach also needs to be demonstrated — do crowded receptors generally discriminate between different metals depending on the choice of detection method? And could other sensing channels be used, perhaps to detect targets other than metal ions?

Schmittel and Lin's work also shows how molecular devices[10] are increasingly flexing their minuscule muscles. The authors' molecule is single-handedly taking on the jobs of four sensors. This augurs well for the 'lab on a molecule' concept[9] — the idea that a set of tasks previously carried out by, for instance, a full clinical lab and a medical practitioner could instead be squeezed onto a single molecule. Such a possibility may seem implausible, but the concept stems from research in molecular logic and molecular computation[11], a field that itself was considered impractical not so long ago.

Schmittel and Lin's work belongs to the field of multi-mode transducers[5], molecular devices that convert chemical 'signals' into several other forms. An associated hot topic of research is the burgeoning area of array-based sensors, in which several molecular sensors are positioned on a single chip[12] or on the tip of an imaging fibre-optic[13]. The common thread of these approaches is that they detect many chemical targets; this might lead to increased efficiency in applications as diverse as cell physiology and environmental monitoring of industrial waste. Taken together, these developments send a clear signal that analytical chemistry is undergoing yet another reincarnation, reaffirming its reputation as a vibrant area of science and technology. ■

A. Prasanna de Silva is at the School of Chemistry and Chemical Engineering, Queen's University, Belfast BT9 5AG, UK.
e-mail: a.desilva@qub.ac.uk

1. Schmittel, M. & Lin, H.-W. *Angew. Chem. Int. Edn* **46,** 893–896 (2007).
2. Bishop, E. (ed.) *Indicators* (Pergamon, London, 1972).
3. de Silva, A. P. *et al. Chem. Rev.* **97,** 1515–1565 (1997).
4. Kaifer, A. E. & Gomez-Kaifer, M. *Supramolecular Electrochemistry* (Wiley-VCH, Weinheim, 1999).
5. Jimenez, D. *et al. Eur. J. Inorg. Chem.* 2393–2403 (2005).
6. Richter, M. M. *Chem. Rev.* **104,** 3003–3036 (2004).
7. Gratzel, M. *Inorg. Chem.* **44,** 6841–6851 (2005).
8. Izatt, R. M. *et al. Chem. Rev.* **85,** 271–339 (1985).
9. Magri, D. C., Brown, G. J., McClean, G. D. & de Silva, A. P. *J. Am. Chem. Soc.* **128,** 4950–4951 (2006).
10. Balzani, V., Venturi, M. & Credi, A. *Molecular Devices and Machines* (Wiley-VCH, Weinheim, 2003).
11. de Silva, A. P., Gunaratne, H. Q. N. & McCoy, C. P. *Nature* **364,** 42–44 (1993).
12. Wright, A. T. & Anslyn, E. V. *Chem. Soc. Rev.* **35,** 14–28 (2006).
13. Walt, D. R. *Science* **308,** 217–219 (2005).

50 & 100 YEARS AGO

50 YEARS AGO

A joint meeting of the Institution of Electrical Engineers, the American Institute of Electrical Engineers and the Engineering Institute of Canada was held on January 24, during which the lecture theatres of these three bodies in London, New York and Montreal were connected together by the trans-Atlantic telephone cable, which was opened for public service last September... At the end of the symposium the clarity of transmission over the cable was demonstrated when identical recordings of music were played in London and New York... Without the indicator provided in the lecture theatre in London, it would have required a very sensitive musical ear to determine the source of the music.

From *Nature* 16 February 1957.

100 YEARS AGO

Death has been very busy of late among the army of men of science, and nowhere has he been more active than in Russia, where within the space of a few weeks three of that country's foremost chemical philosophers—Beilstein, Mendeléeff, and Menschutkin—all men of front rank and of a worldwide reputation, have submitted themselves to the strict arrest of the fell sergeant... Our immediate concern is with the most distinguished of the eminent triumvirate—Dmitri Ivanovitsch Mendeléeff...he was a Siberian, born at Tobolsk on February 7th (N.S.), 1834. He died, therefore, within a week of his seventy-third birthday. He was the seventeenth and youngest child of Ivan Paolowitch Mendeléeff... The story of the rise and development of the Periodic Law is so well known that it is unnecessary now to dwell upon it. By a good fortune, which some may regard as evidence of predestination, Mendeléeff lived to see the verification of his predictions in the discovery, in rapid succession, of gallium, scandium and germanium; and no seer ever prophesied more truthfully.

From *Nature* 14 February 1907.