

Bio-energy

Biofuel cells from roaches

Jon Evans

US researchers have created a tiny biofuel cell to generate electricity from a live organism – a cockroach (*JACS*, doi: 10.1021/ja210794c). Their biofuel cell consists of two carbon fibre electrodes separated by a polymer: the anode is impregnated with two enzymes that break down the sugar trehalose, while the cathode is impregnated with an oxidase enzyme.

The scientists, at Case Western Reserve University in Cleveland, US, inserted the electrodes into the insect's circulatory system which carries nutrients including trehalose around the insect's body. At the anode, the two enzymes break down trehalose to release electrons, which travel to the cathode, where they combine with oxygen from the atmosphere to generate water. As a result, the biofuel cell is able to generate electricity with a maximum current density of $460\mu\text{A}/\text{cm}^2$.

'An insect equipped with a sensor could measure the amount of noxious gas in a room, broadcast the finding, shut down and recharge for an hour, then take a new measurement and broadcast again,' says lead researcher Daniel Scherson.

Meanwhile, biofuel cells could also potentially power 'smart' medical implants in our bodies. As a first step, US nanoengineers led by Joseph Wang at the University of California, San Diego, have developed a combined biofuel cell/drug delivery system that operates by Boolean logic (*Angew. Chem.*, doi: 10.1002/ange.201107068).

Their biofuel cell consists of a bare carbon electrode as the anode and a gold electrode coated with a conducting polymer as the cathode, which is impregnated with a drug commonly used to control pain relief in abdominal injury. Once implanted in the body, the biofuel cell generates electricity if the anode encounters both lactic acid (LAC) and the enzyme lactate dehydrogenase (LDH), which are biomarkers for abdominal damage. In that case, the LDH breaks down LAC at the anode, releasing electrons that travel to the cathode, where they trigger drug release.

This was confirmed when Wang and his team tested the biofuel cell in the laboratory. This means the biofuel cell was acting as an AND gate, providing a mechanism to ensure that the drug is released only when required.

Dead Sea minerals deal agreed

Israel's cabinet has agreed a plan with Israel Chemicals (ICL) whereby the major potash producer will pay \$796m to extract salt build-up on the floor of the Dead Sea and double the royalties it pays on minerals extracted from the area. The deal followed months of negotiations between the two parties after

the Israeli government insisted ICL fund the clear-up, saying that it was responsible for the salt build-up caused as a byproduct of mineral extraction and potash production. The work could significantly affect the profits of ICL, the second-largest company traded in Tel Aviv and one of the world's largest potash producers.

Paul Hodges
chairman, International eChem



Oil prices highs mean trouble lies ahead

Last year saw Brent oil prices, the global benchmark, hit a record annual average price of \$111/bbl. They were higher than in 2008, when the daily price momentarily came close to \$150/bbl. This news spells trouble for the chemical industry.

I first discovered the impact of high oil prices as a new graduate recruit to ICI in 1978. Prices were then rising from \$14/bbl to average \$37/bbl in 1980 – \$97/bbl in today's money. And initially, as the poet William Wordsworth once wrote, 'bliss was it in that dawn to be alive!'

We increased our product prices every month, as the oil price rose. And our volume hit record levels, as buyers scrambled to protect themselves from future price increases. The division's profits, needless to say, were at record levels by the end of 1979, and we celebrated with a party on the scale of those seen in financial circles prior to 2008.

Sadly, 1980 proved to be a different story. As soon as the oil price stopped rising during Q1, the buyers stopped buying. At first, we assumed they were simply working off a little excess inventory, built up during the panic period. But then the summer came and went, and still demand didn't return. We were learning the hard way that the cash-strapped consumer had been forced to stop buying the products on which our sales depended.

The division lost money for

'We were learning the hard way that the cash-strapped consumer had been forced to stop buying the products on which our sales depended'

several years after 1979 as a result, until oil prices crashed back down to \$14/bbl in 1985.

Bruised by that experience, I am now suspicious when someone tells me 'this time is different'. Since 1980, there have been three periods when the oil price averaged close to current levels – in today's money – for sustained periods: in 1990/1, 2007/8 and 2011. All followed the same pattern, which was seen initially in 1973/4. And all have led directly to a global recession.

The reason is not hard to find. Oil is a significant cost to the global economy. Today's oil bill represents 5% of global GDP, compared with 3% in 2009. Poor consumers have no choice but to pay today's higher prices for petrol, and to heat their homes. So it is inevitable that they have less money to spend on the more discretionary products that drive chemical industry growth. I fear recession is, once again, just around the corner as a result. ●