

Materials science

# Tubular gel mimics peristalsis

Jon Evans

Japanese scientists have produced a self-oscillating tubular gel that exhibits peristaltic motion – the same type of wave-like behaviour produced by passage of food through the body's intestines.

Ryo Yoshida at the University of Tokyo first developed a self-oscillating gel in the mid-1990s by taking advantage of the Belousov-Zhabotinsky (BZ) reaction. Unlike most chemical reactions, BZ reactions never reach an equilibrium, but instead cycle continuously between oxidised and reduced states.

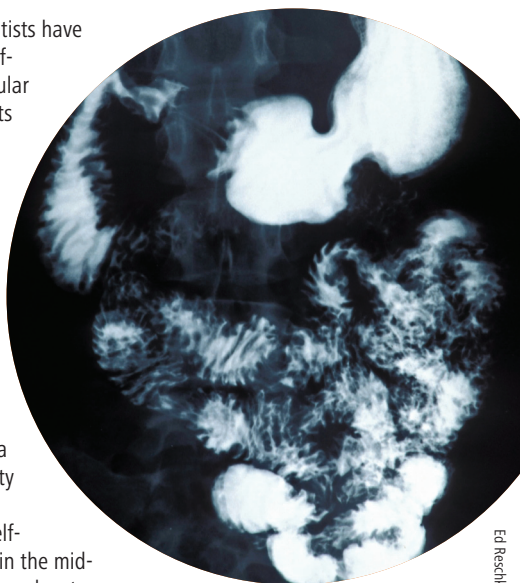
By incorporating a BZ catalyst within a polymer gel and then exposing it to a BZ solution comprising sodium bromate in acids, Yoshida caused chemical waves to pass through the gel as the BZ catalyst cycles between oxidised and reduced states. As these waves pass through the gel, they cause it to swell and then shrink, producing the kind of rhythmic, autonomic movement often found in nature, such as in the beating of the heart or the peristaltic motion of the intestine.

To create a tubular version of this gel, Yoshida and colleague Yusuke Shiraki coated the gel solution onto the inside of a glass capillary and exposed it to UV light, before removing the tubular gel from the capillary. The end result was a hollow polymer tube around 0.7mm wide and a few millimetres long (*Angew. Chem.*, doi: 10.1002/anie.201202028).

By incorporating a non-oscillating polymer into the outer layer of the tube, they were able to produce a version in which only the inner walls of the tube swell up and down, replicating the peristaltic motion seen in a real intestine.

Also just like an intestine, this peristaltic motion can transport objects. The BZ reaction naturally generates carbon dioxide and single bubbles of carbon dioxide were naturally pushed along the tube by the swelling wave, at a speed of 2mm a minute.

'The next step is to design the chemical and physical structure of the gel more precisely for more effective oscillation, and to devise the systems for wider use,' Yoshida says. He is already working to develop a novel micropump for microfluidic systems based on the tubular gel.



Ed Reack/KenGerty

Paul Hodges  
chairman, International eChem



## Auto sector needs new direction

Cars are now the single largest market for the chemical and polymer industry. In the US, the American Chemistry Council estimates that each new car contains around \$3300 of chemicals, and the total is probably similar in Europe. This includes plastics for the bumpers, windows and fascia; paint for the bodywork; tyres; antifreeze; and interior furnishings.

Thus in 2007, the European market was worth \$47bn, with total car sales at 14.4m. But since then sales have been in continual decline, despite government support via 'cash-for-clunkers' deals. In 2011, car sales were down to 12.5m, with a chemicals value of \$41bn.

Importantly, however, the German market remained strong during this period. And many manufacturers were able to increase export volumes to China and other emerging economies to compensate for lower domestic sales. So the European chemicals industry didn't suffer from the downturn as much as might have been expected.

Today, however, this situation is changing. The domestic European market continues to decline and latest figures suggest the German market has also gone 'ex-growth'. Meanwhile export markets are likewise weakening. China's market grew just 2% from January to April 2012, versus 2011, as the government ended the major stimulus measures, which had previously supported demand.

Thus the European industry and its chemical suppliers need to take stock and chart a new direction. An ageing population, with an

unprecedented 29% of the Western world now in the New Old 55+ generation, means that domestic demand patterns are changing quite dramatically. Parents no longer need to taxi children to all their activities. Neither do they need to drive to the superstore at the weekends to fill up with provisions for the week.

Renault's new sales focus provides an excellent example of what this means for suppliers to the industry. Renault has led the way within Europe in focusing on the low-cost segment, and 30% of its sales are now in this area, accounting for 814,000 vehicles last year – double the percentage of five years ago. Financially, it has also proved successful, with operating margins above 6% in the low-cost segment, versus Renault's average 2.6%.

The *Dacia* is its leading model. Key to its success is a realisation that buyer values have changed. *Dacia* buyers have limited incomes and are focused on value for money. Thus its real competition is the used car market. And so, as the head of their entry-level business explains, 'we start by asking ourselves how much clients are prepared to pay, for example for air-conditioning, and then ask the supplier to propose a solution within a set price, including our margin.'

This is clearly a new way of operating for many suppliers, including those in the chemicals industry. But Renault's example shows it could be very profitable for those companies who are alert to the opportunities from the major demographic changes now taking place. ●