Polymer changes its glass transition temperature on contact with water

Keeping your powder dry

Ever wondered why there is a little packet marked 'Do not eat' inside the box for your new DVD player? It's there to absorb moisture that could potentially damage the equipment, but how do you tell if it has been exposed? Chemists from the US think they have the answer with a humidity sensor that irreversibly changes colour on contact with water.

Many coloured dye molecules exhibit different properties when isolated from, or associated with, one another. This effect has been known for many years, but now Christoph Weder and colleagues from Case Western Reserve University have used this property to develop a moisture sensor.

Dye molecules within a polymer matrix can be effectively isolated from one another by rapidly cooling the polymer–dye mixture below its glass transition temperature (think of how inflexible a piece of rubber tubing becomes if you freeze it in liquid nitrogen). If the polymer is heated above its glass transition temperature, then the dye molecules can aggregate and cause a colour change – an effect used in the past for temperature sensors.

The trick to making this sensor work was to design a polymer system that changes its glass transition temperature on contact with water. Exposure of the team's polyamide to a humid atmosphere causes a change in the glass transition temperature from -50°C to well below 0°C, and a corresponding irreversible colour change from green to orange.

'What we'd like to do next is investigate whether we can change the properties to create specificity for other analytes,' said Jill Kunzelman, one of Weder's team. This seems to be a very realistic goal: Qinetiq research fellow Ian Sage said: 'The new sensor shows good potential for a low cost device whose properties can be tuned for a particular purpose.'

Stephen Davey

Reference

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Fast and cheap PCR on a microchip

Magnetic force drives device

A magnet-driven microchip can rapidly and reliably replicate DNA, for many uses including forensic investigation at crime scenes.

The polymerase chain reaction (PCR) is a tool for replicating DNA. Copies are made by passing DNA fragments through three different temperature zones, each cycle doubling the amount of DNA.

The miniature PCR device designed by Nam-Trung Nguyen and colleagues at Nanyang Technological University, Singapore, is simpler and more reliable than existing methods because magnetic force is used to drive the DNA sample around the microchip rather than a pump mechanism. Pumps are expensive and put high mechanical requirements on the microchip as the channels have to withstand high pressures.

In Nguyen’s system, the DNA sample flows continually through a circular closed loop, driven by a plug controlled by an external permanent magnet. As the sample goes around the microchannel loop it passes through the three temperature zones. Successful PCR was achieved in less than four minutes,” said Nguyen.

The time taken for the fluid to cycle around the zones can be adjusted by changing the speed of the external magnet. According to Nguyen, the magnet is a good way to drive the system as it is low cost, has small power consumption and a flexible number of PCR cycles.

“Other similar designs face problems of temperature control, high driving pressures and leakage,” said Nguyen, “but the implementation of this chip in a complex lab-on-a-chip system should not have these issues. ‘Our aim is to develop an integrated system for fast screening of DNA samples at a crime scene,” said Nguyen.

Alison Stoddart

Reference

Y Sun et al. Lab Chip. 2007, 7, 1012 (DOI: 10.1039/b700576h)

Alkanes produced in two simple processes

From glycerol to gas

Liquid alkane fuel can be produced from a by-product of biomass processing, thanks to researchers from the University of Wisconsin, Madison, US.

As the world’s reserves of petroleum dwindle, finding alternative sources of fuel is becoming increasingly important. Producing liquid alkanes from biomass is attractive because its use produces less carbon dioxide, and so it impacts less on global warming. Liquid alkanes have advantages over other biofuels, such as ethanol, for use as transportation fuels because they can be used in existing engines and distributed using infrastructure already in place.

James Dumesic and co-workers devised a system that involves the integration of two processes. The first process is the production of synthesis gas, a mixture of carbon monoxide and hydrogen, from glycerol. The second is a Fischer–Tropsch synthesis, where the synthesis gas is converted to hydrocarbons. Both processes are catalytic, with the first being endothermic and the second exothermic, and the system operates at low temperature and moderate pressure. In integrating the two processes Dumesic’s team found that they could feed the synthesis gas produced in the first process directly into the second without purification.

They also found that in addition to the liquid alkanes produced, the gaseous and aqueous phase by-products include methanol and ethanol, useful in their own right. Dumesic said that this gives the potential to improve the economics of green Fischer–Tropsch synthesis by reducing capital costs and increasing thermal efficiency”.

Madeleine Chapman

Reference


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