Bio-inspired polymer synthesis enhances structure control

May 2 2012

A new bio-inspired approach to synthesising polymers will offer unprecedented control over the final polymer structure and yield advances in nanomedicine, researchers say.

In a study published last week in the prestigious journal *Nature Chemistry*, researchers from the University of New South Wales in Sydney and the University of Warwick in the UK have outline a new method of polymer synthesis based on a combination of segregation and templating – a pair of natural approaches that have evolved over billions of years to direct complex biological processes.

Segregation improves biochemical control in organisms' cells by organising reactants into defined, well-regulated environments, while the transfer of genetic information is a primary function of templating, states the paper.

"The ability to synthesise polymers with such precision and control will enable us to tailor-make polymers for specific needs, with major applications in materials chemistry, nanotechnology and nanomedicine," says co-author Associate Professor Per Zetterlund, Deputy Director of the Centre for Advanced Macromolecular Design (CAMD) in the School of Chemical Engineering at UNSW.

Polymers are large molecules comprising thousands of small molecules – or monomers – bonded together to form a chain-like structure. Polymers can have different properties and functionality depending on their

constituent parts, and a range of high-tech applications.

One way of growing these chains is through a process known as radical polymerisation, which uses free radicals. These are molecules or atoms with unpaired electrons and are consequently very reactive. Free radicals initiate chain growth by adding to a monomer unit, explains Zetterlund. This generates a new radical that adds to the monomer unit again, and so on, in a continuing process.

However, conventional radical polymerisation yields polymers of ill-defined structure, says Zetterlund: they have a wide-range of molecular weights, the monomer sequence distribution along the chain is difficult to control and the length of the chain cannot be predetermined.

"One of the long-standing goals in synthetic polymer chemistry is to be able to synthesise polymers of well-defined microstructure," says Zetterlund. "Our approach offers much better control over molecular weight distributions, gives access to higher molecular weights, and offers potential to control tacticity and monomer sequence distribution."

This allows researchers to better control the physical and mechanical properties of the polymer, which determines its functionality, and could enable sequence-controlled polymerisation and thus controlled polymer folding, two pinnacles of polymer science, says Zetterlund.

"The overall structure in biopolymers is dictated by how the polymer chains fold – or arrange themselves in space – as exemplified by the DNA double helix," explains Zetterlund. "To be able to mimic such behaviour, it is necessary to be able to prepare polymers with very specific distributions of monomers along the chain."

Provided by University of New South Wales