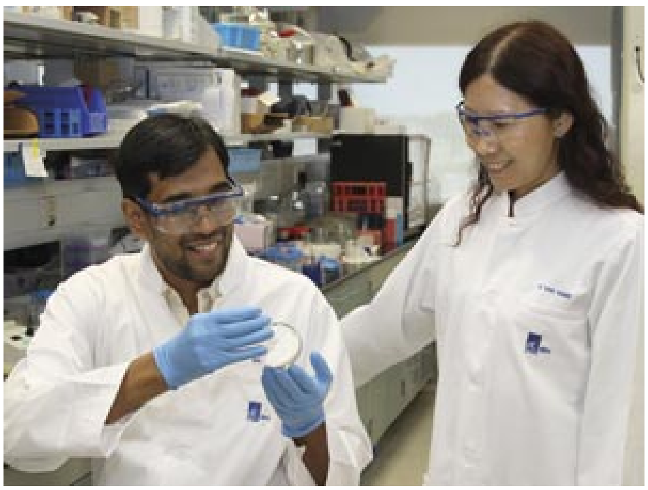
Rapid synthesis of ring-shaped molecules offers a cheap route to a plethora of polymers

June 15 2016



Yi Yan Yang (right) with co-worker Shrinivas Venkataraman. Credit: A*STAR Institute of Bioengineering and Nanotechnology

A simple and inexpensive method to make a range of cyclic monomers has been developed by A*STAR researchers. These new monomers were used to make biodegradable polymers with potential applications from drug or gene delivery to environmentally-friendly packaging.

There are many established commercially-viable routes to non-degradable synthetic polymers, but making degradable analogs remains time-consuming, difficult and expensive. Yi Yan Yang at the A*STAR Institute of Bioengineering and Nanotechnology and co-workers have now developed a two-stage route to degradable polycarbonates that overcomes these issues.

Firstly, the team devised a two-step method to synthesize ring-shaped monomers with a wide variety of different functional groups. "These eight-membered aliphatic cyclic carbonate monomers were made from commercially-available materials that are extremely inexpensive, such as diethanolamine," explains Yang. "We shortened the monomer synthesis route from five or six steps to two steps, which translates to lower production cost."

Secondly, the team found that a ring-opening polymerization reaction using an organocatalyst proceeded with excellent predictability over the size of the polymers formed.

Yang was surprised by how well her team's synthetic route works. "The formation of medium-sized rings is known to be synthetically challenging, so we didn't expect the facile formation of these rings would work without the need for special reaction conditions," she says.

In addition, polymerizing such cyclic monomers can be difficult. "Therefore, it was a very nice surprise to discover that these eight-membered cyclic monomers can be polymerized well using organocatalytic ring-opening polymerization after the reaction conditions and catalysts are optimized."

The route is suitable for use on an industrial scale, confirms Yang. "The starting materials are inexpensive, in addition, the synthetic conditions are quite mild and can be easily scaled up."

For a polycarbonate synthesized by this method, one potential application is for gene or drug delivery. The theory is that the polymer will degrade and release its cargo once it reaches the desired site in the body. Polymers can be synthesized to contain secondary amine functional groups, able to bind to DNA, for example. "Or we could install hydrophobic functional groups to deliver hydrophobic anticancer drugs," says Yang. Functional groups that enable the polymer to work as an antimicrobial can also be easily added. Yang's group is currently working on using this platform to make polymers for various medical applications.

The method could also be used to make biodegradable polycarbonates, for uses such as packaging materials. "This inexpensive, novel robust platform could potentially be used to prepare next-generation degradable packaging materials," Yang says.

More information: Shrinivas Venkataraman et al. A Simple and Facile Approach to Aliphatic-Substituted Functional Eight-Membered Cyclic Carbonates and Their Organocatalytic Polymerization, *Journal of the American Chemical Society* (2015). DOI: 10.1021/jacs.5b06355

Provided by Agency for Science, Technology and Research (A*STAR), Singapore

Citation: Rapid synthesis of ring-shaped molecules offers a cheap route to a plethora of polymers (2016, June 15) retrieved 26 April 2024 from https://phys.org/news/2016-06-rapid-synthesis-ring-shaped-molecules-cheap.html