Scientists discover a natural adhesive with biomedical applications

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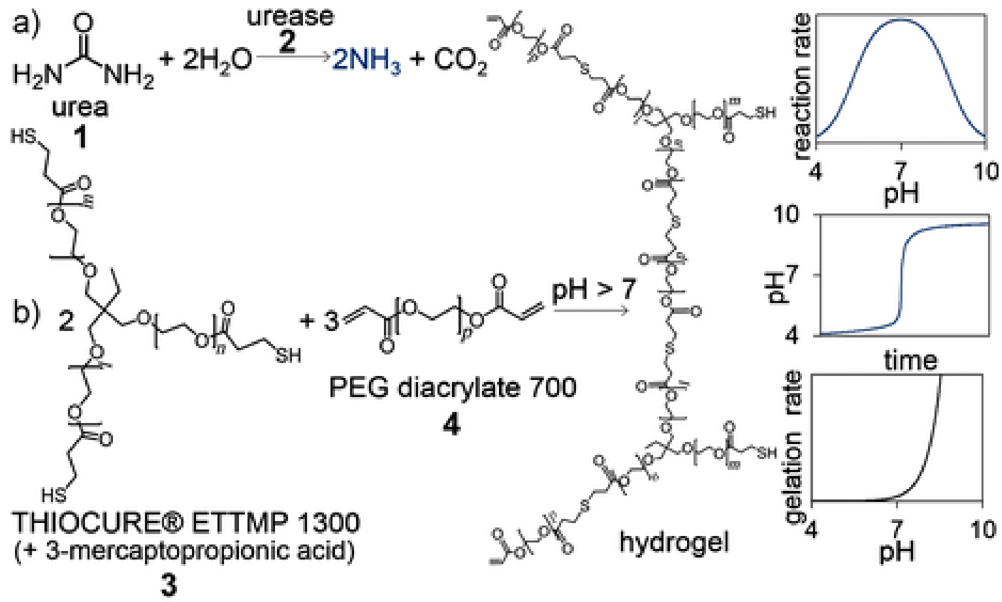

a) The reaction of urea and urease (1,2) produces a base that drives b) thiol–acrylate (3,4) gelation after an induction period. Sketched graphs show the dependence of the urea–urease reaction rate on the pH value, the resultant pH–time curve, and the dependence of the thiol–acrylate gelation rate on the pH value. Credit: *Angewandte Chemie International Edition* (2016). DOI: 10.1002/anie.201510604

Chemists created a nonpermanent adhesive from a natural chemical reaction that can be used in the biomedical field. This discovery may benefit tissue repair or drug delivery. The scientific journal *Angewandte*

Chemie recently published this collaborative work between LSU and University of Sheffield researchers.

The scientists studied the natural chemical process that occurs when urea, a molecule found in urine, is broken down by the enzyme urease, which produces ammonia and carbon dioxide. Based on previous studies, scientists know how long it takes urease to break down urea, which can be used to create a chemical process called a "pH clock reaction." They chose urea and urease because it is one of the few nontoxic and natural clock reactions. By adding water and two chemicals—a sulfur-based thiol and a synthetic acrylate—during the urea-urease clock reaction, the researchers were able to create a thin, water-soluble adhesive gel.

LSU doctoral candidate Elizabeth Jee led the study. Jee tested more than 20 different combinations of chemicals in this experiment before achieving the intended reaction.

"I was so excited. I jumped up and down and ran into the office to tell my lab mates that my experiment worked," said Jee, who will receive her doctorate in August from the LSU Department of Chemistry.

As the urease breaks down the urea and ammonia is produced, the watery solution changes from acidic to basic. The molecules then begin to build a framework of polymers that entraps water, and the solution solidifies into a gel that resembles Jell-O. In the study, Jee identified how long it takes urease to break down urea, how long it takes the gel to form, at which time the gel will break down in a basic solution and how the solution reacts in different sized containers.

"By tuning the properties of this system, we can adjust the rate of degradation, which might be desirable in a biomedical adhesive or drug carrier in your body," Jee said.

Her Ph.D. advisor, Professor John Pojman, has developed a variety of polymer adhesives and clays that can be manipulated through chemical processes such as applying heat. This latest research is based on previous urea-urease pH clock reaction research he conducted with a collaborator in England.

More information: Elizabeth Jee et al. Temporal Control of Gelation and Polymerization Fronts Driven by an Autocatalytic Enzyme Reaction, *Angewandte Chemie International Edition* (2016). DOI: 10.1002/anie.201510604

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