Green Gel: Hybrid material made from polymers and proteins fluoresces and respnods to pH value and temperature

Researchers at the University of California, Berkeley have now developed a new strategy for the formation of hybrid materials from synthetic polymers and proteins. They have thus been able to fuse the specific biological functions of proteins with the advantageous bulk and processing properties of plastics.

Polymer-protein hybrid materials may be of use in the manufacture of sensors, nanomachine parts, or drug-delivery systems. As Aaron P. Esser-Kahn and Matthew B. Francis report in the journal *Angewandte Chemie*, they have successfully synthesized a green-fluorescing biodegradable gel that responds to changes in pH value and temperature.

Previous processes for the production of hybrid materials depended on very specific coupling techniques that could not be used for some protein side-chains. In contrast, the new method developed by the Berkeley researchers is broadly applicable because in principle it is suitable for any protein.

The coupling occurs at both ends of the protein chain—and these are the same for all proteins: one amino acid group and one carboxylic acid group. Initially, two parallel but mutually independent (orthogonal) reactions are used to activate the two ends of the chain.

These are then attached to special chemical “anchor points” on the polymer. The proteins thus cross-link the individual polymer chains into a three-dimensional network, forming what is known as a hydrogel. A hydrogel is a solid, gelatinous mass consisting of water incorporated in a polymer network. A well-known example of a hydrogel is the soft contact lens.

Francis and Esser-Kahn chose to use a protein that fluoresces green to cross-link their polymer chains. Because the protein maintains its normal folding pattern even after attachment to the polymer, the fluorescence is also maintained: The entire gel fluoresces green.

This hybrid material has a special trait: the cross-linking of the polymer chains is achieved exclusively by means of the proteins. Because proteins can be attacked by proteases, enzymes that disintegrate proteins, these gels are biodegradable. The green fluorescence of the protein is pH-dependent. The gel correspondingly also reacts to changes in pH. It only fluoresces in the basic range; in a lightly acidic medium, the gel no longer fluoresces. Raising the temperature also elicits a response from the gel. The protein denatures at about 70 °C, which quenches the fluorescence and causes the gel to shrink.

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