Seminar

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Polymer-Protein Hybrid Systems: From Damage Self-Reporting Materials to ATRPases

Protein-polymer hybrid systems comprising synthetic polymers and functional proteins or enzymes combine the best of two worlds: The possibility to synthesize materials with desired properties, the processibility of man-made macromolecules and the highly evolved functionality, responsiveness and catalytic activity of nature's polypeptides.

We have doped polymers and fiber-reinforced composites with engineered proteins, such as fluorescent proteins and a chaperonin. Microcracks, delamination defects and other damages were reported by the proteins in the materials through a change in their fluorescent properties, e.g. a change in fluorescence resonance energy transfer (FRET) or the vanishing of fluorescence. These signals could be observed by simple methods, e.g. by fluorescence microscopy, thus allowing to detect microscopic damaged areas that might be the nucleus of catastrophic material failure.

Furthermore, we have investigated protein-based catalysts for atom transfer radical polymerization (ATRP). By conjugating Cu-complexes into the cavity of a protein cage, the chaperonin thermosome, we were able to conduct ATRP in the confined volume of a protein nanoreactor, leading to an enhanced control over the reaction. In the course of this project we discovered that some native enzymes and proteins, such as horseradish peroxidase and hemoglobin, show catalytic activity in ATRP reactions, making them the first examples of ATRPases. As enzymes are environmentally friendly and non-toxic, ATRPases could become green alternatives to conventional ATRP catalysts.

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