Yoshie LAB.

[Material Design Based on Polymer Dynamics Control]

Integrated Research Center for Sustainable Energy and Materials

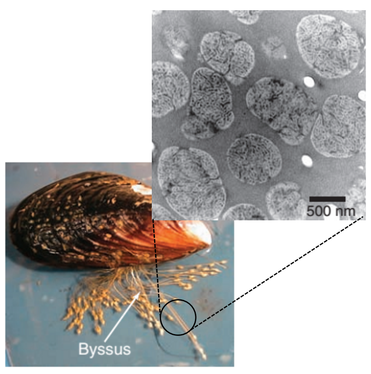
Environment-Conscious Polymeric Materials Science

Department of Chemistry and Biotechnology

http://yoshielab.iis.u-tokyo.ac.jp/

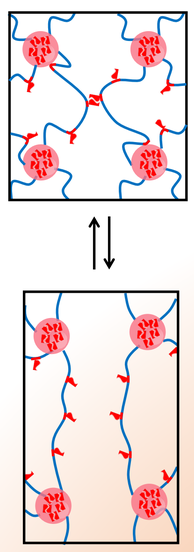
We create new high-performance materials such as tough, self-healable elastomers and robust nanocomposites, by dynamically controlling hierarchical structure of polymeric materials spanning from molecular to mesoscopic scales.

Bio-inspired tough polymer



Mussel

inspired



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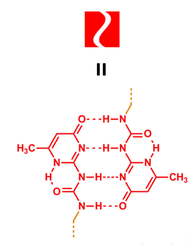
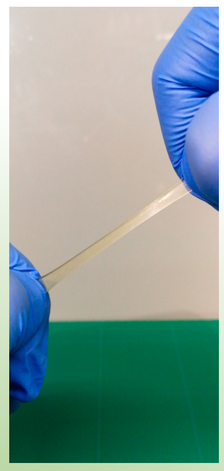


Dynamic crosslinks by quadruple hydrogen bonds

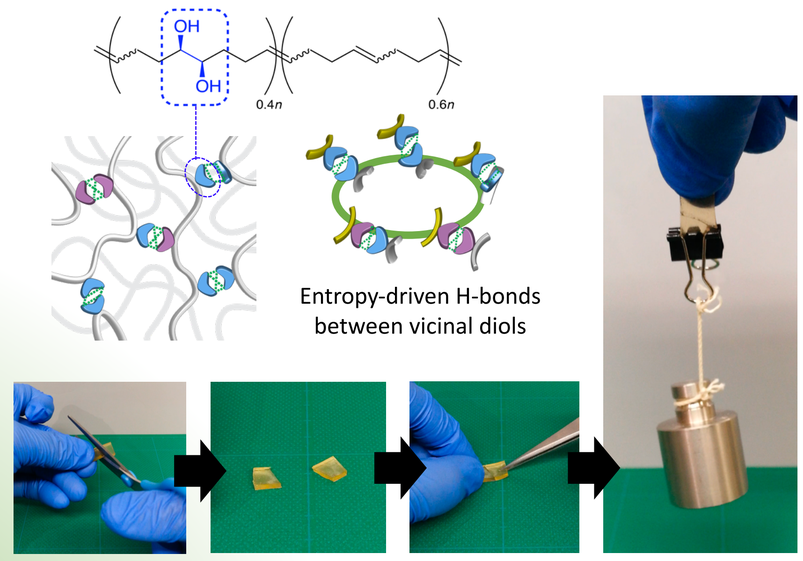
Tough & Self-recoverable

Mussels have a string-like tough organ called *byssus* to fix themselves to rocks. Inspired by the multiphase structure formed by dynamic crosslinks in byssus, we developed a new material with high toughness and excellent self-secoverability.

Tough rubber that heals by itself



Tough

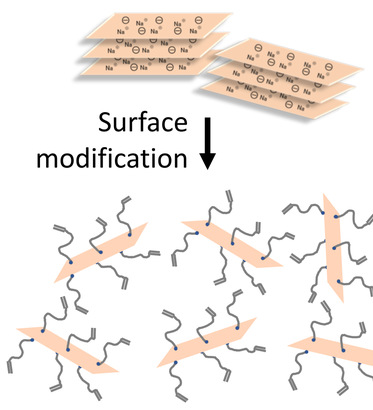


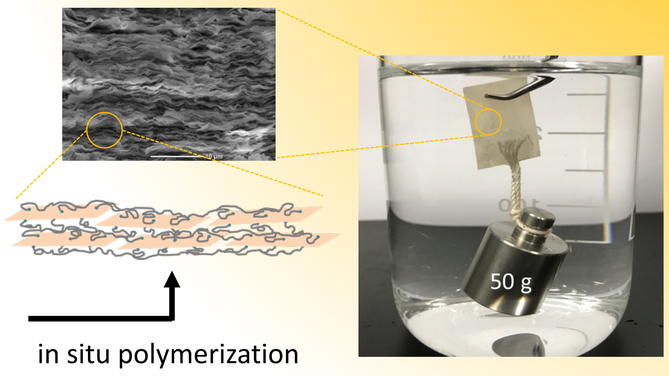
Self-healable at room temperature

What if materials like rubber can heal their wounds by itself? It will greatly prolong the materials' lifetime. We discovered that hydrogen bonds between very simple chemical motifs (vicinal diols) make a rubber mechanically tough and self-healable.

Functional materials by tuning dynamic structure

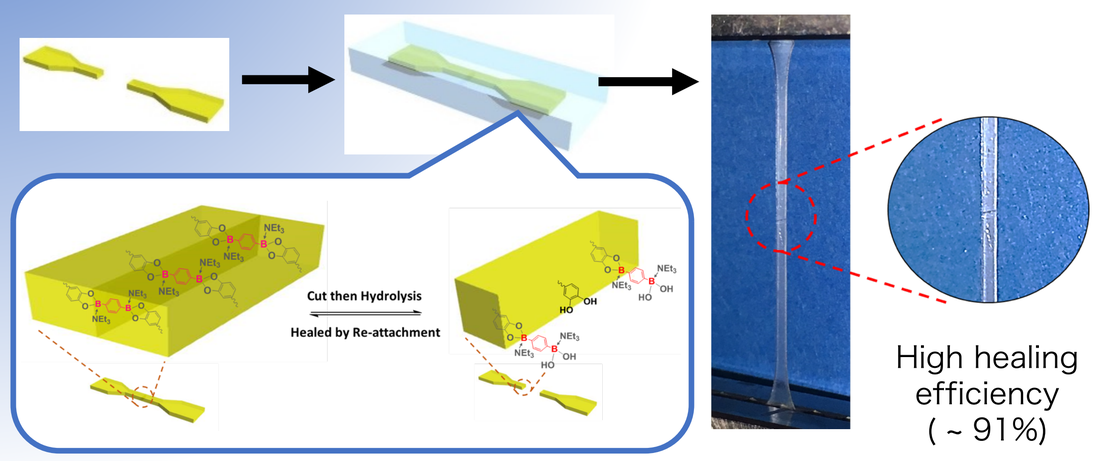
Rigid & water-proof organic/inorganic nanohybrid





Nacre in sea shells is an organic/inorganic nanohybrid consisting of alternating layers of plate-like minerals and organic polymers and is known for its high rigidity and low permeability. However, artificial nacre-mimetic materials are often water-sensitive because of high hydrophilicity of the inorganic component. We developed a rigid, water-proof nanohybrid by combining the surface modification and in situ polymerization techniques.

Seawater-assisted self-healable polymer



Self-healing in polymeric materials assisted by water is gaining much attention. However, such a material is generally hydrophilic and hence its mechanical property decreases in water. Using hydrophobic dynamic bonds (boronic ester) we developed a polymer that is stable and self-healable in sea water.