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

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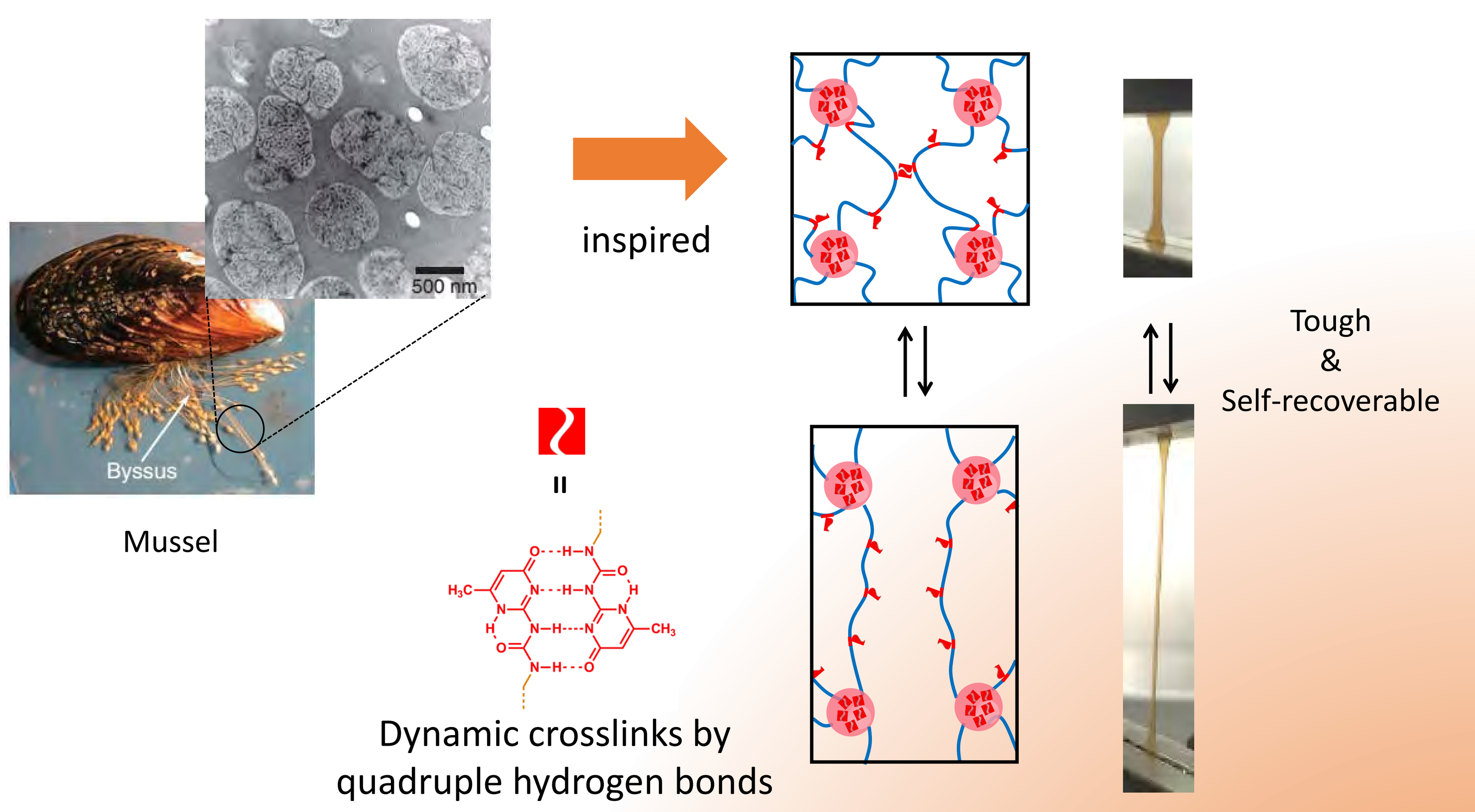
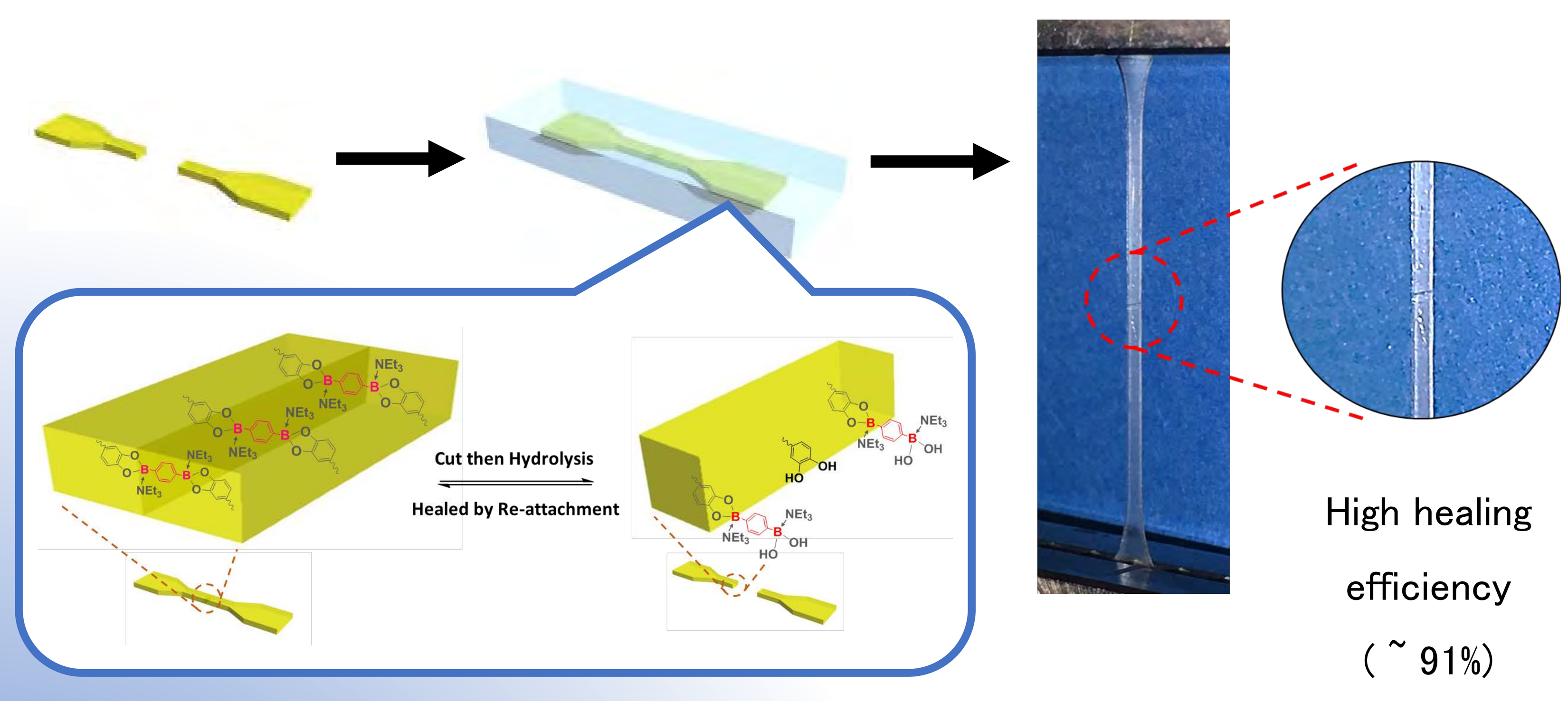
We create new high-performance materials such as tough and self-healable elastomers and nano-patterned surface, by dynamically controlling hierarchical structure of polymeric materials spanning from molecular to mesoscopic scales.

Bio-inspired tough elastomer

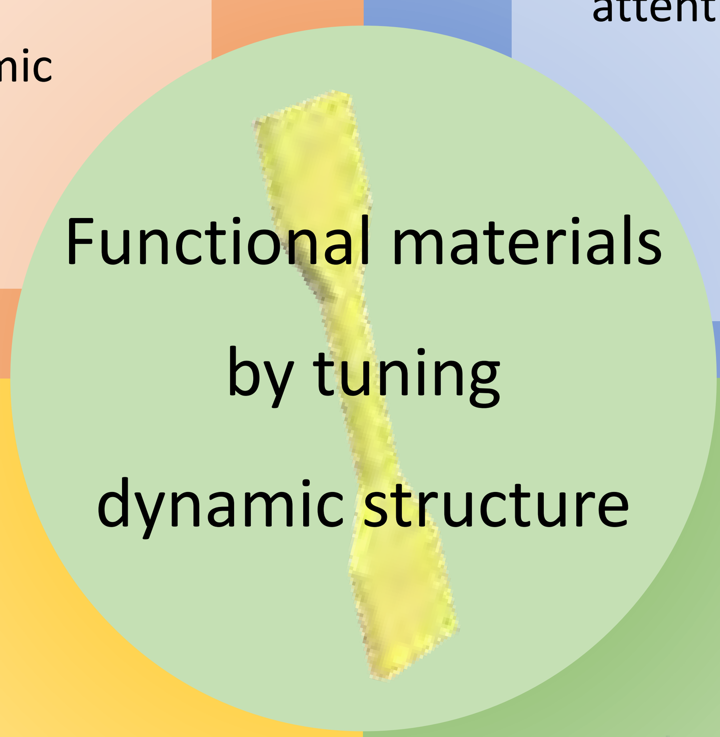


Mussels have a string-like tough organ called *byssus* to fix themselves to rocks. Inspired by the multiphase structure formed by dynamic crosslinks in byssus, we developed a new material with high toughness and excellent self-secoverability.

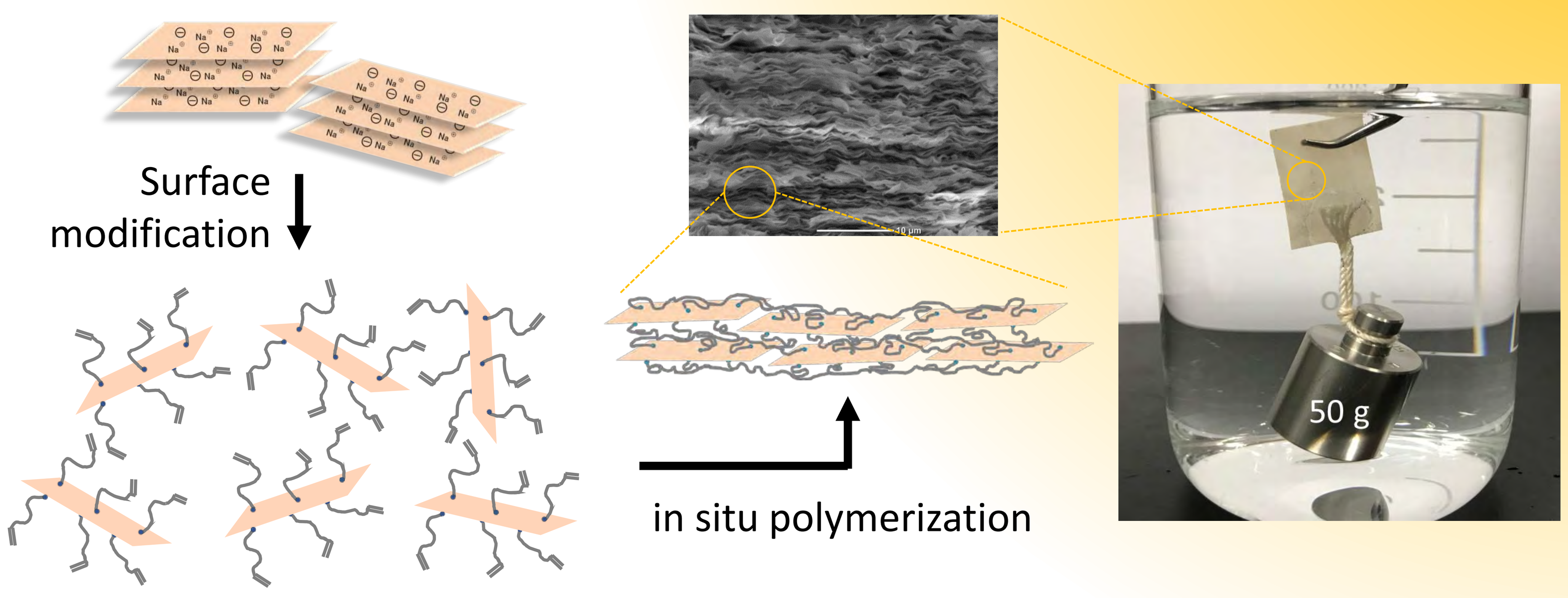
Seawater-assisted self-healable elastomer



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 an elastomer that is stable and self-healable in sea water.

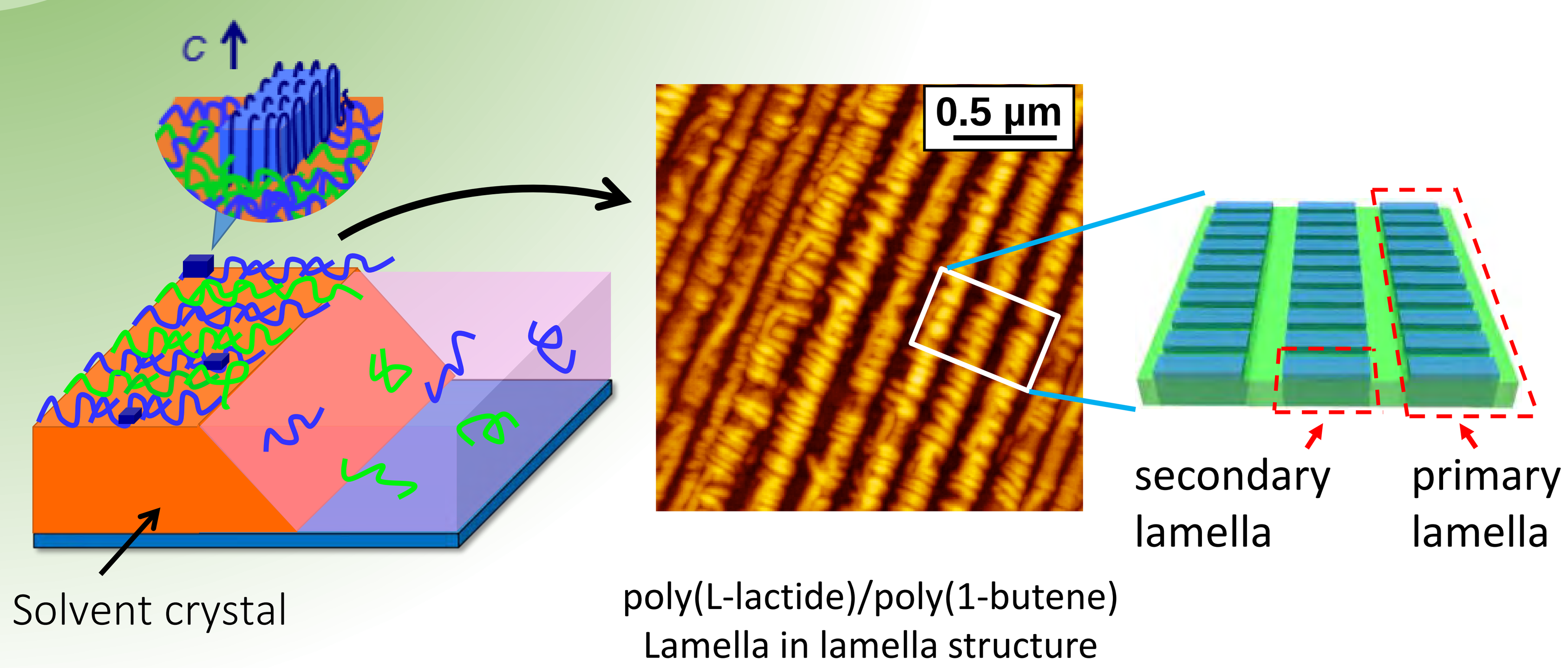


Rigid & water-proof organic/inorganic nanohybrid



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.

Nano-patterning by dynamic phase separation



poly(L-lactide)/poly(1-butene)
Lamella in lamella structure

Just like water and oil, a blend of two different polymers phase-separate and form poorly ordered structure. We discovered a method to fabricate highly ordered nano-patterns from simple polymer blends based on freezing of the directional phase separation process.