The Chinese University of Hong Kong

Department of Biomedical Engineering

Graduate Seminar – PhD Oral Defence

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Date	:	6 June 2019 (Thursday)
Time	:	10:00 am
Venue	:	Room 513, William M W Mong Engineering Building (ERB)

Title: Precision and Rational Engineering of Bio-inspired Hierarchical Polymeric Networks for Biomedical Engineering Applications

Marine mussel foot proteins, known for their robust adhesion to virtually all kind of substrates under wet and saline conditions, have greatly inspired the development of mussel-mimetic polymeric networks containing catechol groups with diverse applications in the fields of biomedicine and tissue engineering. However, numerous previous attempts to emulate the mussel adhesion in synthetic materials are largely limited to the simple grafting of catechol groups in polymers, such as polysaccharides and polyethylene glycol (PEG). The role of local microenvironmental factors around catechol and the synergistic interplay of various supramolecular interactions in mussel foot proteins in mediating the robust mussel adhesion still remain largely unexplored.

Herein, we report several hierarchical polymeric networks composed of diverse supramolecular interactions for mimicking the supramolecular architectures of mussel adhesion proteins. Firstly, we report an approach for fabricating dual-crosslinked tough adhesive hydrogels with defined crosslinkers based on pre-assembled nDMA/AAPBA complexes. By effectively enhancing both the interfacial adhesion and bulk cohesion, the fabricated adhesive hydrogels possess ultrahigh adhesion energy on wet biological tissues. Secondly, we synthesized mussel foot protein (MPM) precursors through Ugi four-component reaction for fabricating multiphase-structured ultra-tough elastomers. Under external tensile forces, the hard nanodomains can provide a high stiffness and help blunt the advancing crack tip, while the dynamic iron-catechol complexes within the hard hydrophobic nanodomains effectively dissipate loading energy and reduce the stress concentration on the hard nanodomains around the notch, thus leading to a record-high level of fracture energy of 24,000 J m^{-2}. Thirdly, we developed self-coacervates of amphipathic MPMs polymeric nanoparticles stabilized by hydrogen bonding as dynamic wet bio-adhesives and compartmentalized 3D cell culture microenvironment. We believe these studies expand the translation scope of the mussel-mimetic polymeric networks from the simple catechol-functionalization to the precision engineering of the supramolecular hierarchical architectures of adhesive polymeric biomaterials by controlling the local microenvironment of adhesive functional groups.

***** ALL ARE WELCOME *****

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