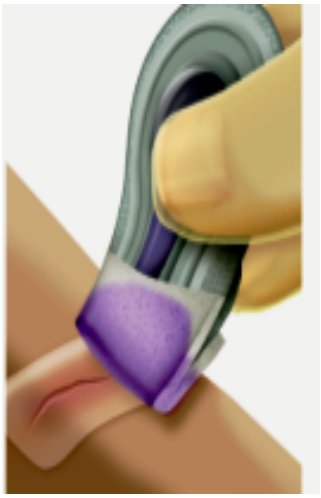
INTERNATIONAL SOCIETY OF
BIONIC ENGINEERING



A Barnacle-Inspired One-Component Biomedical Adhesive

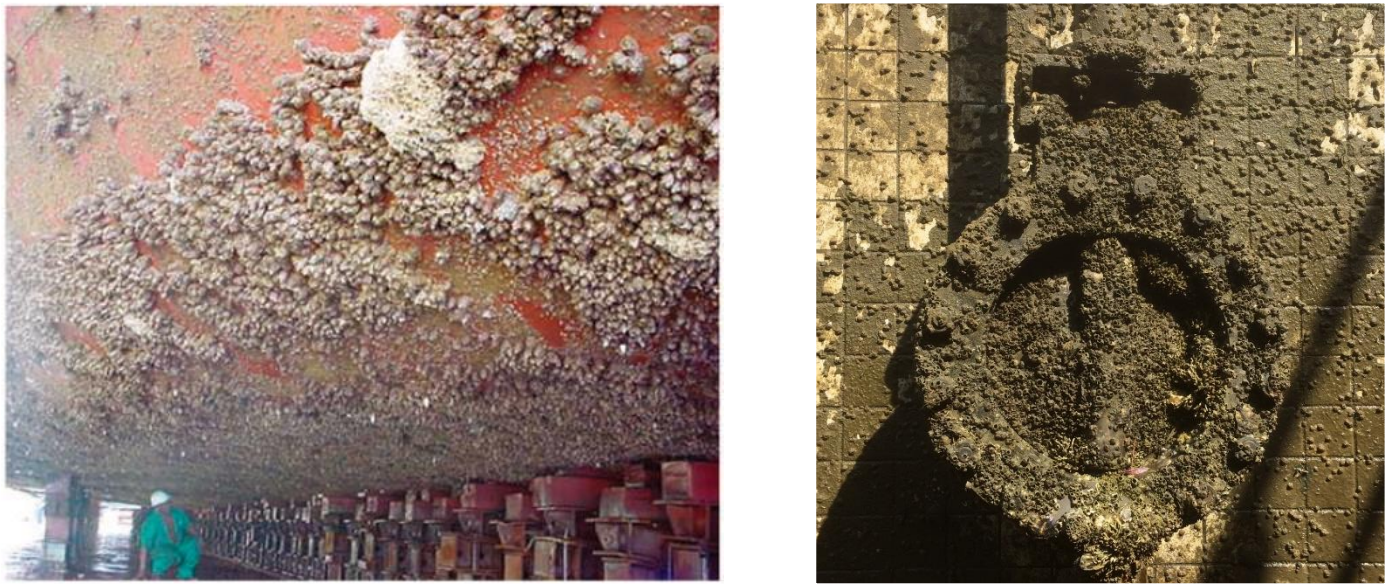
The case was provided by the Individual Member of ISBE

Chao Liang & Biru Hu (hubiru08@nudt.edu.cn)

of National University of Defense Technology

1. Biological Prototype

Barnacles, a marine fouling organism, anchor themselves tenaciously to various substrates in seawater by secreting and curing a multi-protein underwater cement.



Barnacles attaching to ship hulls and water pipelines

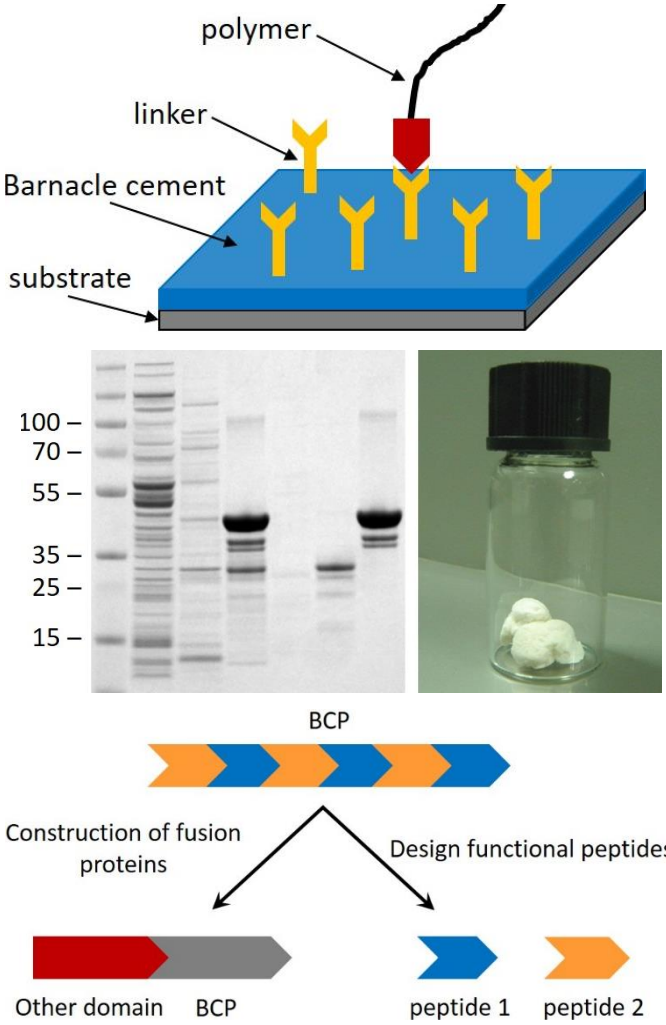
Due to its strong adhesive, water-proof and biocompatible ability, barnacle cement is an ideal model for engineering bio-inspired biomedical adhesives.

***Nature communications*, 2011, 2: 244.**

2. Bionic Study

Bionic studies of barnacle cement have been performed from three different levels:

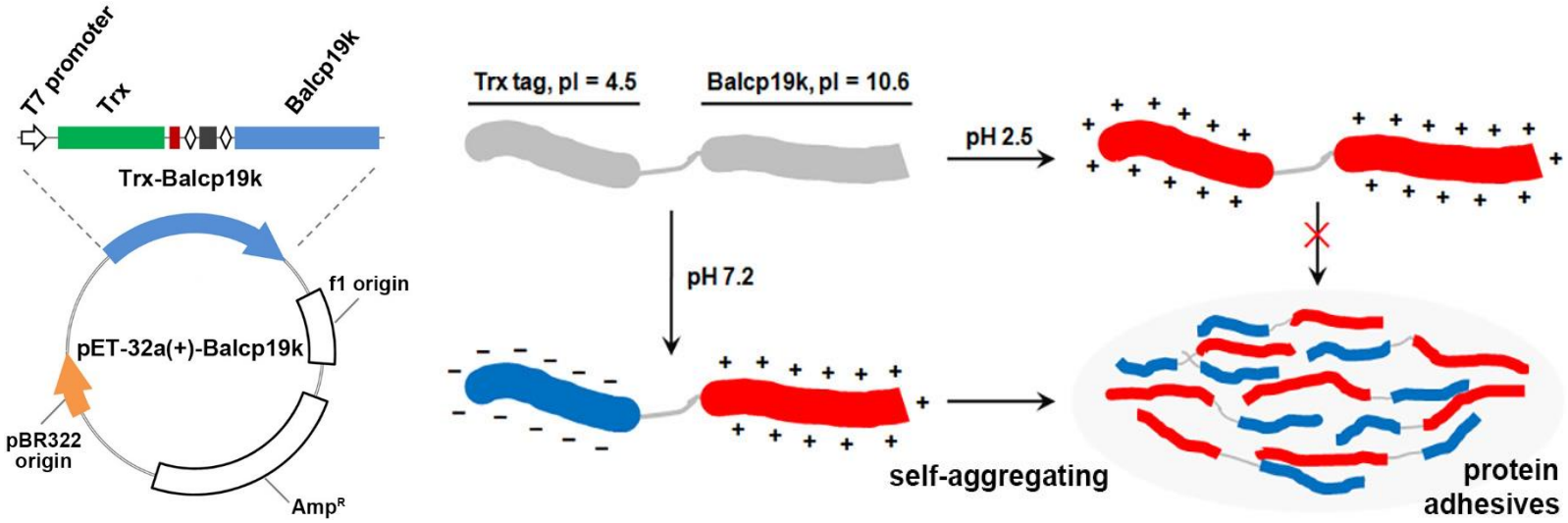
- **Taking advantage of natural barnacle cement directly for surface modification.**
- **Reconstitution of barnacle cement through producing recombinant barnacle cement proteins (BCPs).**
- **Design of functional molecules inspired by BCPs.**



Biomacromolecules, 2013, 14: 2041-2051
Biochemistry, 2015, 54: 826-835.

3. Design and Processing

To fabricate a barnacle-inspired one-component adhesive, thioredoxin (Trx) with an acidic isoelectric point (pI) was fused with Balcp19k having a basic pI to construct the hybrid protein Trx-Balcp19k.



Here, the adhesive protein Balcp19k plays the surface binding role while the Trx tag mediates inter-molecular electrostatic attractions at suitable conditions, leading to self-aggregating protein adhesives.

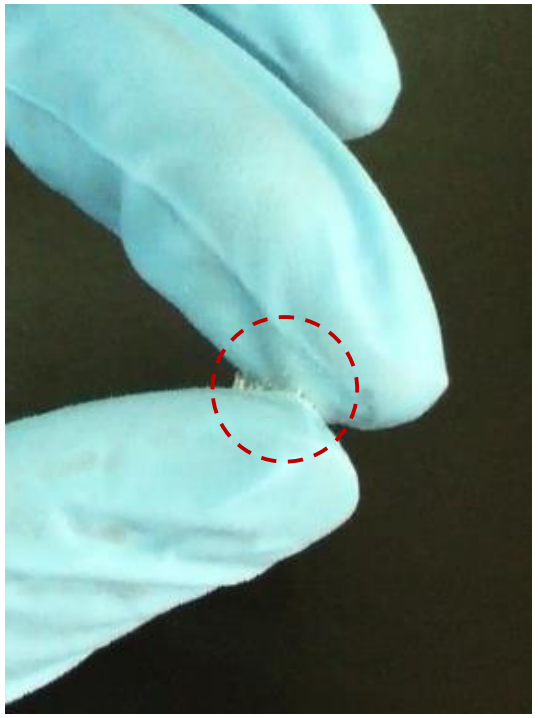
***PLoS ONE*, 2015, 10: e0136493.**

3. Design and Processing

Based on our design, a super sticky gel-like adhesive called Trx-Balcp19k gel was successfully fabricated by producing recombinant Trx-Balcp19k and dialyzing it against pure water to trigger intermolecular electrostatic attraction.

Super sticky Trx-Balcp19k gel

Lyophilized Trx-Balcp19k gel

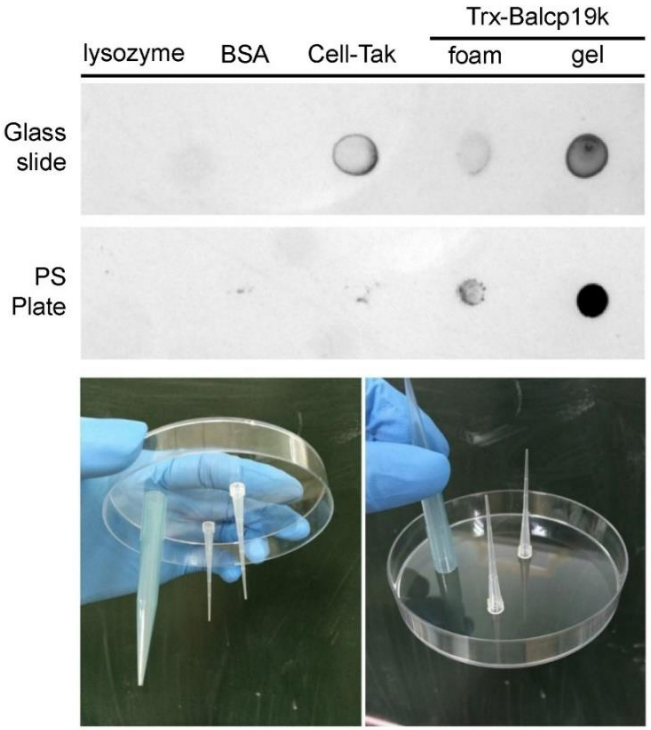


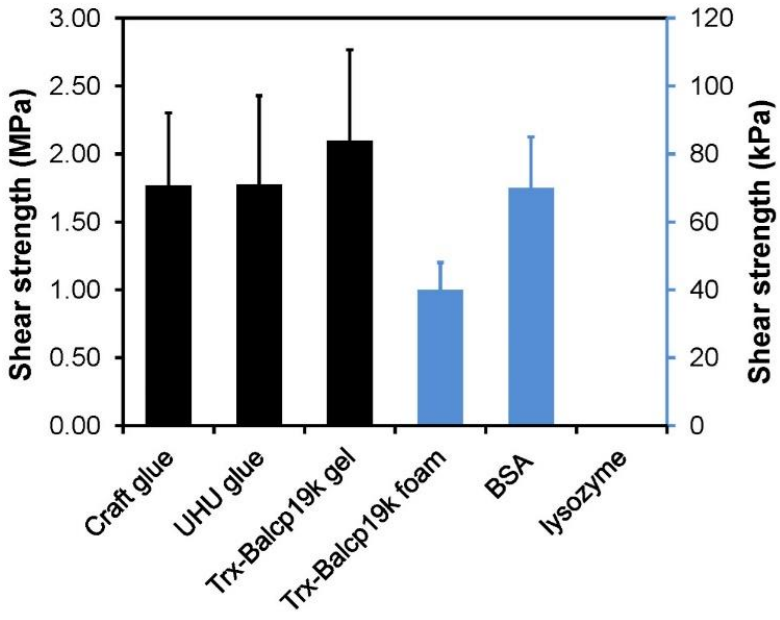
Trx-Balcp19k gel adhesive fibers

3. Design and Processing

Trx-Balcp19k gel can adhere to a variety of substrates and stick different objects together, such as plastics as well as broken ribs together.

Quantitative test shows that it has an adhesive strength of 2.10±0.67 MPa in air, comparable to several commercial glues and recombinant mussel foot proteins.

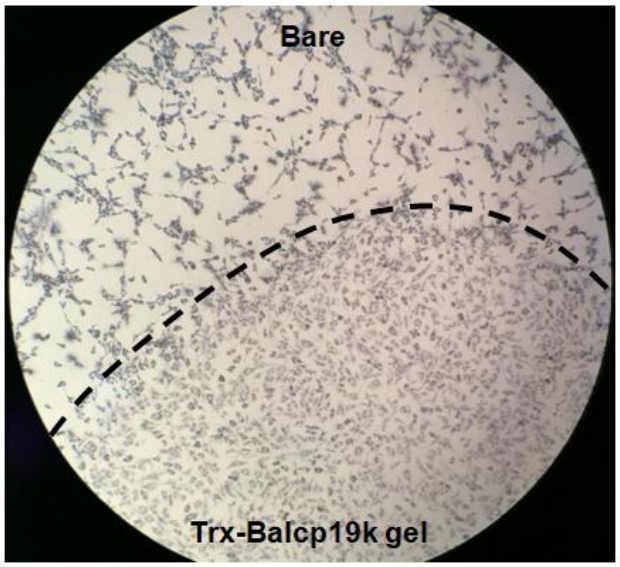


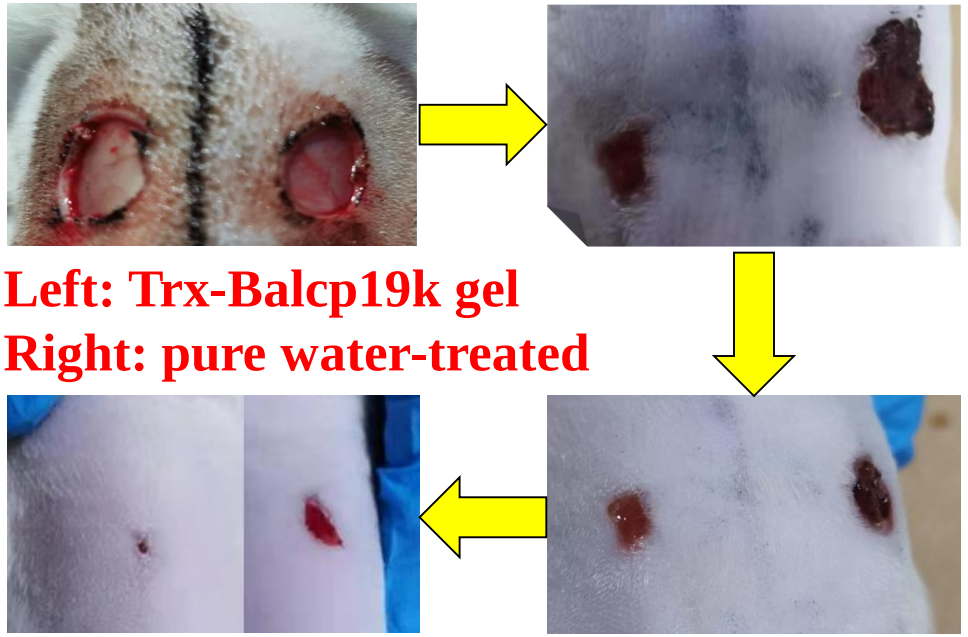


4. Achievements and Application

Trx-Balcp19k gel exhibits good cell compatibility and is capable of promoting cell adhesion.

Animal experiments show that it can markedly accelerate the healing process of rat skin traumas compared to pure water-treated controls.





Left: Trx-Balcp19k gel
Right: pure water-treated

Trx-Balcp19k gel promotes cell adhesion and wound healing

- **We have successfully engineered a barnacle-inspired, super adhesive, one-component protein adhesive.**

- **The adhesive displays good biocompatibility and can promote cell adhesion and would healing, exhibiting great potential for biomedical applications.**