Protein-Based Biomaterial Design: Drawing Inspiration from Mussel Adhesive Proteins

***Yang Wei*[1*], Yiran Li[2], Ting Han, Jian[1], Nareshkumar Baskaran[1], Phillip B. Messersmith[2]**

[1]*Department of Chemical Engineering and Biotechnology, National Taipei University of Technology, 1, Sec. 3, Zhongxiao E. Rd., Taipei 10608, Taiwan*
[2]*Departments of Bioengineering and* Materials *Science and Engineering, University of California, Berkeley, CA, USA; Materials Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA*

**E-mail: wei38@ntut.edu.tw*

Synthetic polymers' strong and effective adhesion to wet surfaces is severely limited by the hydration layer on concrete surfaces [1]. However, marine creatures have evolved exceptional wet adhesion capabilities, with mussels secreting remarkably sticky proteins in their byssus that enable them to attach firmly to surfaces even under seawater [2]. These adhesive proteins, mainly found in the plaque, are known as adhesive mussel foot proteins [3].

To gain insights into the molecular-level binding mechanism of these proteins, we used amino acid labeling and mass spectrometry techniques to identify the configuration of mussel foot proteins adsorbed on a solid substrate, combining the labeling profiles of modified lysine (Lys) and histidine (His). Our findings detail the binding sequence between the mussel adhesive and a solid surface, as explored using a quartz crystal microbalance (QCM) and an atomic force microscope (AFM).

The results of our study can potentially benefit the development of accurate and efficient mussel protein-inspired sequences for designing wet adhesive polymers for specific surfaces. By understanding the mechanism behind the mussel foot protein's adhesive interaction, we can potentially overcome the limitations of synthetic polymers' adhesion to wet surfaces and develop novel, biologically-inspired adhesives.

References

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