

Quandary This! Sticky Science

Explore science that sticks—especially in challenging wet environments.

Adhesives are essential in countless applications, and one of the most persistent challenges in adhesive science is achieving strong, reliable adhesion in wet environments. Adhesives that work in wet environments may not seem important at first, but they play a big role in everyday life and advanced technology. For example, underwater construction—like fixing bridges and ships—need adhesives that can stick even when everything is soaked. In healthcare, adhesives attach sensors and bandages to sweaty skin and even inside the body, where it's always moist. Even electronics like fitness trackers rely on adhesives that can hold up in humid condition.

Unfortunately, water makes it hard for glue to stick properly. Water interferes with many bonding mechanisms, weakening the interactions between adhesive and substrate. Most conventional adhesives rely on dry bonding mechanisms, and the bonding forces are significantly weakened in the presence of water. Water can act as a barrier between the surfaces or disrupt interactions, and even secure bonds can be disrupted by capillary movement of water in wet environments. Follow the exercises in this issue of *Quandary This!* to explore the breakthroughs and challenges in the fascinating world of 'sticky science'.

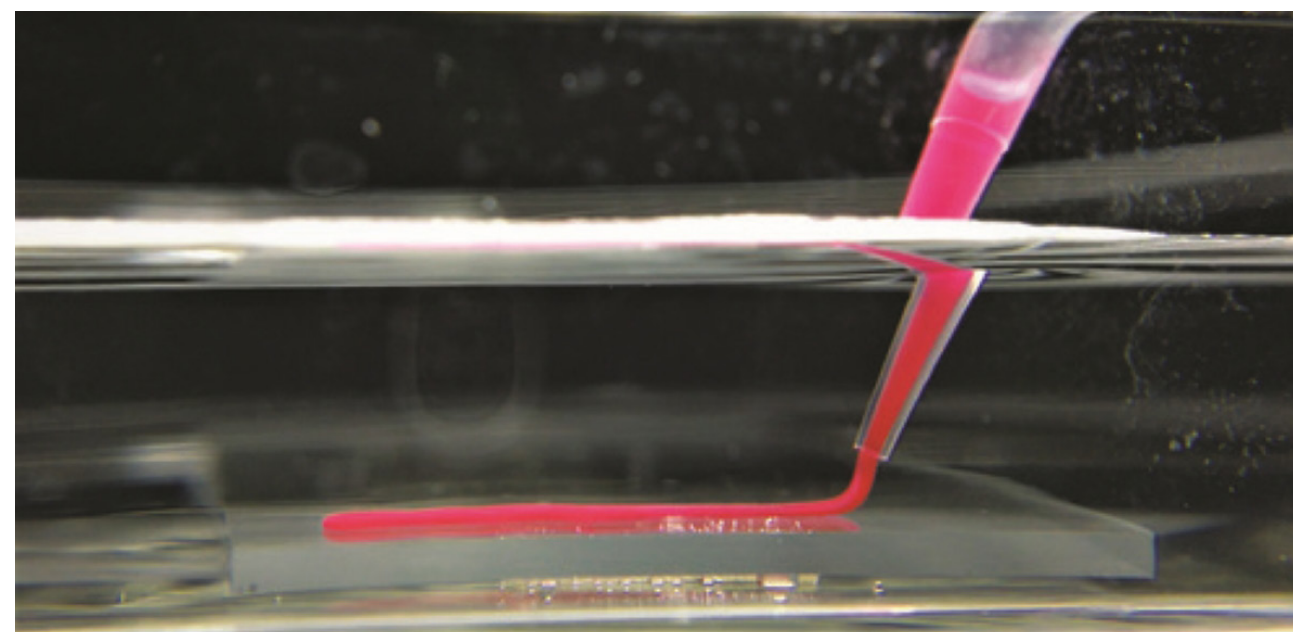
General Questions

Answer the following questions, using the C&EN article "[AI-designed superglue retains extreme strength under water](#)" or another source of your choice.

- Why did scientists turn to nature to look for better alternatives to current adhesives?
- The scientists started with a database of 24,000 adhesive proteins. Where were the proteins originally found?
- What was one thing all of the proteins found in nature shared?
- How did scientists use machine learning (ML) to find better adhesives?
- What are two ways the scientists tested the strength of the new glues in real settings?



READ THE
C&EN ARTICLE



Suggested Reading

This reading list is designed to provide a solid foundation to help answer these challenges. If you encounter content that is not free to read, please ensure you are logged into your institution's library portal.

- [Injectable and Wet-Adhesive Coacervate with Enhanced Photothermal Properties for Localized Tumor Treatment](#)
- [Adhesion Evolution: Designing Smart Polymeric Adhesive Systems with On-Demand Reversible Switchability](#)
- [Density Functional Theory Study on the Cross-Linking of Mussel Adhesive Proteins](#)
- [Gecko's Feet-Inspired Self-Peeling Switchable Dry/Wet Adhesive](#)
- [Fabrication of High-Sensitivity Skin-Attachable Temperature Sensors with Bioinspired Microstructured Adhesive](#)
- [Interfacial Hydrogen Bond-Reinforced Adhesion and Cohesion Enabling an Ultrastretchable and Wet Adhesive Hydrogel Strain Sensor](#)
- [Fabrication of Bioinspired Hydrogels: Challenges and Opportunities](#)
- For citations, use the [ACS Style Quick Guide](#).

Challenge 1: Literature Research

Learn the critical skill of searching trusted sources of information, such as peer-reviewed literature, to find answers to specific questions.

For each of the following questions, provide an answer and cite the source of your information in ACS style. You can view citation examples and guidance in the [ACS Style Quick Guide](#).

- What are two reasons that coacervate has superior wet-adhesive capabilities than fibrin glue?
- What are five common interactions at the interface of an adhesive and the substrate?
- What is the functional group that makes marine mussels' bond so strong?
- How can a material switch from being adhesive to detaching—what can trigger the switch?
- What is a method of determining the chemical structure of hydrogels and other adhesives?



SUGGESTED
READING

Challenge 2: Essay Investigation

Hydrogels are a promising material due to their toughness but face challenges when it comes to their adhesive properties. Adhesive hydrogels often are not durable enough for long-term use. In 200-400 words, discuss the possible ways to overcome this challenge.

Challenge 3: In-Depth Analysis

Uncover understanding around the business and legal implications of technological advance.

Finding adhesives that work effectively underwater remains a challenge, but new options are becoming available each year. One example is a [patent for an adhesive](#) developed by Northwestern University, which cites an article by Zhang et al. Given that patents are designed to secure ownership of novel discoveries and patent citations typically paint the landscape of "prior art" to demonstrate that their discovery is novel, what claim does the patent make that could be considered an advance upon the discoveries outlined in this article? (Hint: view the citation list to find the articles.)