PURDUE INNOVATES | Office of Technology Commercialization

Underwater Bonding with a Biobased Adhesive

Zein/tannic acid adhesive bonds strongly underwater and is biodegradable for marine and industrial use.

Adhesives play a crucial role in many industries, providing effective and durable bonding of materials. Despite their widespread use, existing adhesives often struggle with performance and long-term durability, especially under adverse conditions or when used with certain materials and application processes. Furthermore, both the production and waste associated with adhesives pose environmental challenges. Petroleum based materials are used for the manufacturing of many adhesives. Air pollution occurs with the use of many solvent-based adhesives and water pollution occurs from use of many emulsion adhesives. Thus, there is a pressing need for an environmentally friendly, non-toxic adhesive that can address these efficacy and versatility issues.

Researchers at Purdue have developed a novel adhesive with impressive performance in underwater environments and on wet surfaces. This adhesive exhibits great versatility, proving effective in various types of water, including tap, deionized, and salt water. Its characteristics allow for broad applicability across several types of materials, demonstrating robust adhesion strength on metal, wood, and limestone. Furthermore, the adhesive developed is more environmentally friendly than standard adhesives, as it is composed of biodegradable materials, such as zein and tannic acid.

The researchers tested adhesion strength over set time intervals and found superior performance of the newly developed adhesive compared to the commonly used adhesives for the 24-hour, one-week, and two-week time intervals. The adhesion strength was also tested on a variety of substrates, showing the versatility of the technology for use in commercial applications. The adhesive also showed remarkable temperature resilience, maintaining its performance over a broad temperature range, with peak performance at room temperature. The researchers were able to show that the adhesive

Technology ID

2022-WILK-69642

Category

Chemicals & Advanced Materials/Green & Bio-Based Chemistry
Chemicals & Advanced Materials/Coatings, Adhesives & Sealants
Chemicals & Advanced Materials/Materials Processing & Manufacturing Technologies

Authors

Logan Miles
Gudrun Schmidt
Jonathan James Wilker

Further information

Aaron Taggart
adtaggart@prf.org

View online

strength was significantly enhanced over time, setting it apart from conventional adhesives. Furthermore, the composition of the adhesive, specifically tailored for underwater environments, demonstrated incredible durability, resisting cohesive and adhesive failure in diverse applications. With the versatility to be applied either underwater or on a wet surface, the technology caters to a broad range of practical needs, making it highly valuable in the industrial and manufacturing sectors.

Technology Validation:

- Lap shear testing was performed on various underwater adhesive comprising of (i) zein, (ii) tannic acid, and (iii) ethanol and water on various substrates (aluminum, bronze and stainless steel)

- Lap shear testing was also performed on samples left in ocean water for varying time periods

- Temperature-dependent underwater adhesive performance was also tested for varying types of adhesive compositions

Advantages:

- Adhesive can be applied in both wet and underwater conditions, making it suitable for a variety of use-cases as metal, wood, and limestone

- Adhesion strength increases significantly with time when the adhesive is kept underwater, and the adhesion strength seems to benefit from exposure to different types of water

- Increased durability: Even after long periods underwater, the adhesive maintains its integrity, becoming harder and more brittle

- Eco-friendliness: Adhesive is composed of zein and tannic acid, which are biodegradable materials and more eco-friendly alternative to traditional adhesives

Applications:

- Marine Construction

- Shipbuilding

- Biomedical Applications

TRL: 3

Intellectual Property:

Provisional-Gov. Funding, 2021-12-16, United States

NATL-Patent, 2022-12-14, Republic of Korea

NATL-Patent, 2022-12-14, Japan

NATL-Patent, 2022-12-14, India

NATL-Patent, 2022-12-14, Canada

NATL-Patent, 2022-12-14, China

NATL-Patent, 2022-12-14, Europe

PCT-Gov. Funding, 2022-12-14, WO

NATL-Patent, 2024-06-14, United States

Keywords: Adhesives, Chemistry and Chemical Analysis, Glues, Green Technology, Materials and Manufacturing, Non-Toxic, Waterproof