Healthcare, Electronics

Cellulose nanofiber coatings against water-induced short-circuit failures

Department of Functionalized Natural Materials, The Institute of Scientific and Industrial Research (SANKEN)

Ph.D Student / Research Fellowship for Young Scientists (DC1) Takaaki Kasuga Researchmap https://researchmap.jp/tkasuga

Professor Masaya Nogi Researchmap https://researchmap.jp/read0151141

Abstract

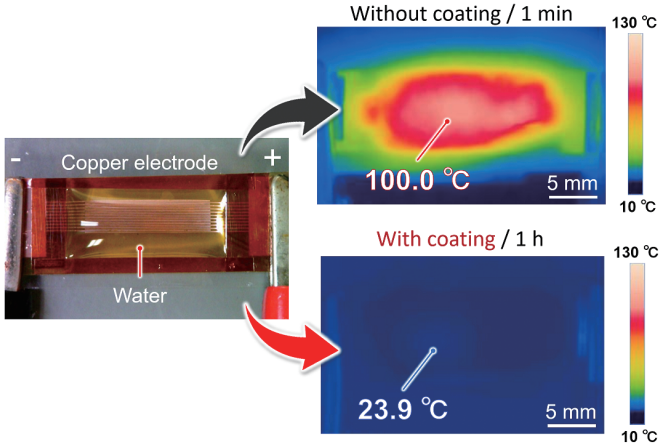
Water is detrimental to electronic devices because it easily causes short circuits. Some electronics can be made at least water-resistant by, for example, using hydrophobic polymers to coat the electronic circuit, however, it is inevitable that water penetrates the sealing material if it is cracked or delaminated, and the water can easily cause malfunctions due to dendrite growth. In this study, we present a cellulose nanofiber coating that can reliably prevent malfunctions caused, even if the waterproof seals are damaged and the circuit becomes wet. The cellulose nanofibers accumulate at the anode due to electrophoresis, thereby forming a cohesive cellulose nanofiber layer that prevents short circuits between electrodes more than 24 h.

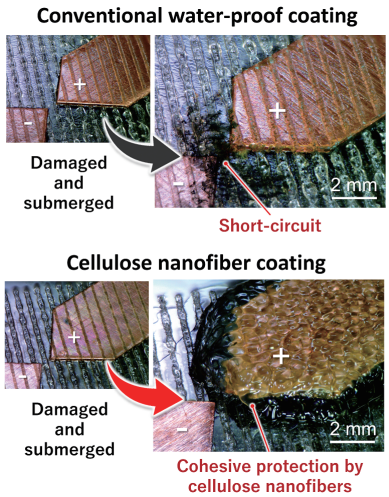
Background & Results

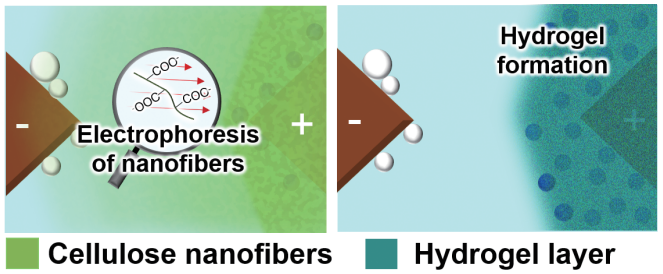
Most electronic devices are not waterproof, and contact with water can easily destroy them. In many cases, sealing with hydrophobic resin is an effective method to prevent water-induced failures. However, in case of next generation electronic devices such as flexible devices and degradable sensor devices, more advanced protections are required. Here, we present a cellulose nanofiber coating that can prevent water-induced short circuit failures effectively. When uncoated Cu electrodes were submerged under water and a voltage was applied, short circuits occurred after 5 min due to the formation of dendrites between the electrodes. On the other hand, short circuit failure was inhibited for at least 24 h with the cellulose nanofiber coating. Redispersion of the cellulose nanofibers occurs in the presence of water. The applied electric field promotes the migration and dispersion of cellulose nanofibers toward the anode, contributing to the formation of a stable protective layer. The cellulose nanofiber coating can be combined with existing sealing technologies to dramatically increase the safety of electronic devices, and can also be applied as a biodegradable circuit protection coating.

Significance of the research and Future perspective

The technology can be easily combined with existing circuit protection technologies and is expected to further improve safety by layering waterproof coating and the cellulose nanofiber coating. In addition, it can be used not only for flexible devices but also for eco-friendly degradable sensor devices which will contribute to reduce environmental pollution and management and decrease the disposal costs of sensor devices. It is expected to be a novel technology that is environmentally friendly and enriches our lives.







Patent	patent pending
Treatise	Kasuga, Takaaki; Nogi, Masaya et al. Cellulose Nanofiber Coatings on Cu Electrodes for Cohesive Protection against Water-Induced Short-Circuit Failures. ACS Appl. Nano Mater. 2021; 4 (4): 3861–3868. doi: 10.1021/acsanm.1c00267
URL	https://www.youtube.com/watch?v=6ENGdrD2vWM&t=105s
Keyword	cellulose nanofiber, circuit protection, wearable devices, SDGs