Scientists develop biocompatible anti-burn nanofibers that act as 'living bandages'

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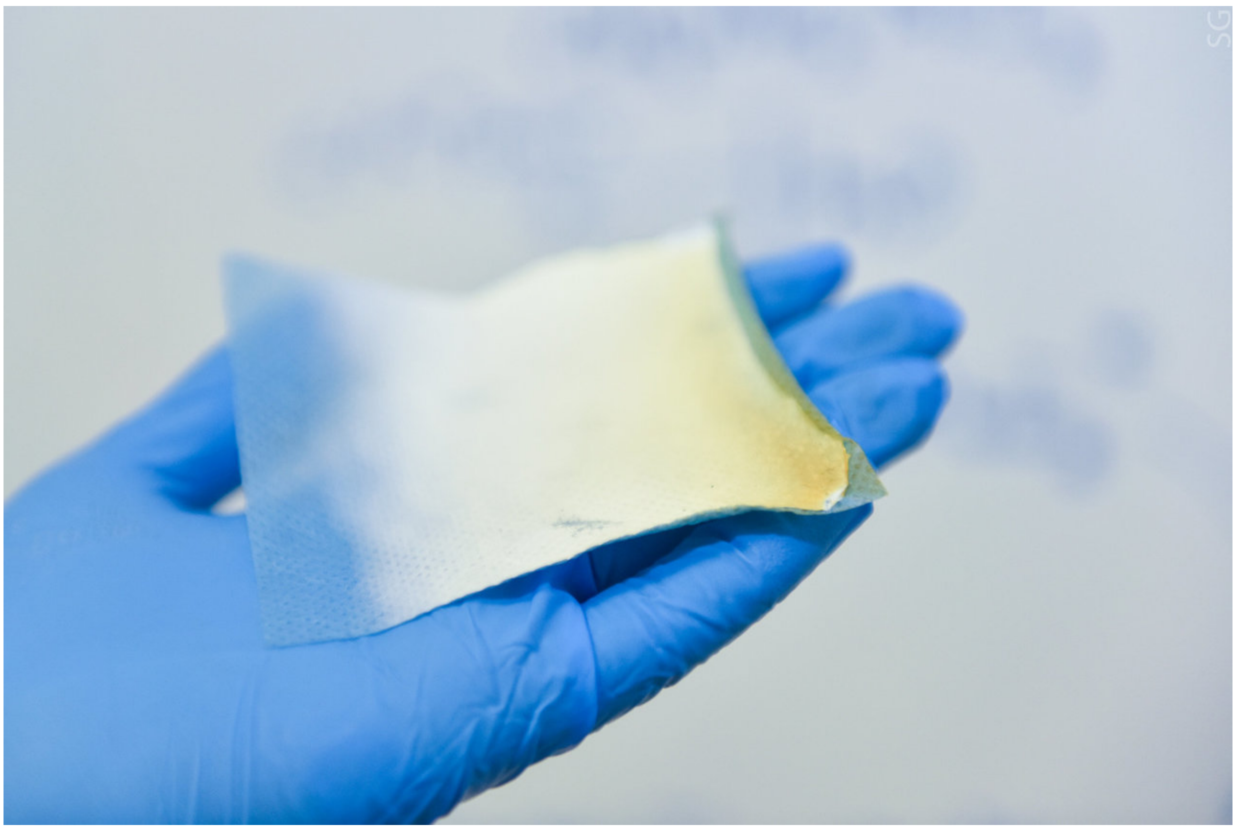

New therapeutic material based on nanofibers made of polycaprolactone. Credit: NUST MISIS

A group of NUST MISIS's young scientists has presented a new therapeutic material based on nanofibers made of polycaprolactone modified with a thin-film antibacterial composition and plasma components of human blood. Biodegradable bandages made from these fibers will accelerate the growth of tissue cells twice as quickly, contributing to the normal regeneration of damaged tissues, as well as preventing the formation of scars in cases of severe burns.

In regenerative medicine, and particularly in burn therapy, the effective regeneration of damaged skin tissue and the prevention of scarring are usually the main goals. Scars form when skin is badly damaged, whether through a cut, burn, or a skin problem such as acne or fungal infection.

Scar tissue mainly consists of irreversible collagen and significantly differs from the tissue it replaces, having reduced functional properties. For example, scars on skin are more sensitive to ultraviolet radiation, are not elastic, and do not develop sweat glands or hair follicles.

A solution to this medical problem was proposed by the researchers from the NUST MISIS Inorganic Nanomaterials Laboratory, led by Ph.D. Anton Manakhov, a senior researcher. The scientist created multi-layer "bandages" made of biodegradable fibers and multifunctional bioactive nanofilms, which prevent scarring and accelerate tissue regeneration.

Elizabeth Permyakova, one of the project members and laboratory scientists. Credit: NUST MISIS

The addition of the antibacterial effect by the introduction of silver nanoparticles or joining antibiotics, as well as the increase of biological activity to the surface of hydrophilic groups (-COOH) and the blood plasma proteins confer unique healing properties to the material.

At the site of injury, the bandages foster a significant acceleration of the healing process, the successful regeneration of normal skin covering tissue, and the prevention of scarring on the site of burnt or damaged skin. The antibacterial components of multifunctional nanofibers decrease inflammation. The blood plasma, with an increased platelet level, stimulates the regeneration of tissues. The bandages are not removed or changed during treatment, as it may cause additional pain to the patient. After a certain period of time, the biodegradable fiber simply "dissolves" without any side effects.

"With the help of chemical bonds, we were able to create a stable layer containing blood plasma components (growth factors, fibrinogens, and other important proteins that promote cell growth) on a polycaprolactone base. The base fibers were synthesized by electroforming. Then, with the help of plasma treatment, to increase the material`s hydrophilic properties, a polymer layer containing carboxyl groups was applied to the surface. The resulting layer was enriched with antibacterial and protein components," noted Elizabeth Permyakova, one of the project members and laboratory scientists.

The research team has conducted a series of pre-clinical trials jointly with the Research Institute of Experimental and Clinical Medicine (Novosibirsk, Russia). In vitro results have shown that the regeneration process occurs twice as quickly as that with standard bandages. In the near future, the team expects to get results of in vivo drug testing.

More information: Anton Manakhov et al, Grafting of carboxyl groups using CO 2 /C 2 H 4 /Ar pulsed plasma: Theoretical modeling and XPS derivatization, *Applied Surface Science* (2017). DOI: 10.1016/j.apsusc.2017.11.174

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