Clothes That Clean Themselves

Australian researchers are developing a process that could lead to self-cleaning wool sweaters and silk ties.

Researchers at Monash University, in Victoria, Australia, have found a way to coat fibers with titanium dioxide nanocrystals, which break down food and dirt in sunlight. The researchers, led by organic chemist and nanomaterials researcher Walid Daoud, have made natural fibers such as wool, silk, and hemp that will automatically remove food, grime, and even red-wine stains when exposed to sunlight.

Daoud and his colleagues coat the fibers with a thin, invisible layer of titanium dioxide nanoparticles. Titanium dioxide, which is used in sunscreens, toothpaste, and paint, is a strong photocatalyst: in the presence of ultraviolet light and water vapor, it forms hydroxyl radicals, which oxidize, or decompose, organic matter. Moreover, the coating does not change the look and feel of the fabric.

Titanium dioxide can also destroy pathogens such as bacteria in the presence of sunlight by breaking down the cell walls of the microorganisms. This should make self-cleaning fabrics especially useful in hospitals and other medical settings. Daoud says that "self-cleaning property will become a standard feature of future textiles and other commonly used materials to maintain hygiene and prevent the spreading of pathogenic infection, particularly since pathogenic microorganisms can survive on textile surfaces for up to three months."

The idea of using titanium dioxide to make self-cleaning surfaces is not new. Titanium dioxide powder is added to paints and as a transparent coating (roughly 10 nanometers thick) on glass to make self-cleaning windows.

To make self-cleaning wool, Daoud and his colleagues use nanocrystals of titanium dioxide that are four to five nanometers in size. In the past, the researchers have made self-cleaning cotton by coating it with these nanocrystals. But coating wool, silk, and hemp has proved more difficult. These fibers are made of a protein called keratin, which does not have any reactive chemical groups on its surface to bind with titanium dioxide.

The researchers chemically modify the surface of wool fibers, adding chemical groups called carboxylic groups, which strongly attract titanium dioxide. Then they dip the fibers in a titanium dioxide nanocrystal solution. The researchers have outlined this process in a paper that recently appeared online in the journal *Chemistry of Materials*.

In the paper, the researchers show how the material stands up to red-wine stains, which are notoriously difficult to remove. Titanium-dioxide-coated wool shows almost no sign of the red stain after 20 hours of exposure to simulated sunlight, while the untreated wool remains boldly stained. Other stains disappear faster: coffee stains fade away in two hours, while blue-ink stains disappear in seventeen hours.

Adapted from *www.technologyreview.com*

1 **Answer the following questions in your own words.**

1. Where was the research conducted?
2. Why is titanium dioxide used to coat fibres?
3. Where can the new fibres be used and why?
4. What is titanium dioxide commonly added to?
5. Why was it difficult to coat wool, hemp and silk?
6. What has been done to help the process?
7. What are the results of the study?
8. What do you think about this innovative practice?
9. Would you be interested in buying self-cleaning clothes?

Production Line For Artificial Skin

— A fully automated process is set to improve the production of artificial tissue: medical scientists can perform transplants with skin produced in the laboratory. This tissue is also suitable for testing chemicals at a low cost without requiring animal experiments.

Some patients wish they had a second skin – for instance because their own skin has been burnt in a severe accident. But transplanting skin is a painstaking task, and a transplant that has to cover large areas often requires several operations. Medical scientists have therefore been trying for a long time to grow artificial tissue. This "artificial skin" would allow them to treat these patients better and faster.

Tissue engineering has been at the focus of research for many years, and tissues such as cartilage or skin are already being cultured in numerous biotechnology laboratories. But the researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB in Stuttgart plan to go a step further than that. They are aiming to enable fully automated tissue production. "Until now, methods of culturing tissue like that used for skin transplants have been very expensive," says IGB head of department Professor Heike Mertsching.

"Most of the steps are carried out manually, which means that the process is not particularly efficient." The researchers have therefore elaborated a novel conceptual design in collaboration with colleagues from the Fraunhofer Institutes for Production Technology IPT, Manufacturing Engineering and Automation IPA, and Cell Therapy and Immunology IZI.

First of all, a biopsy – that is, a sample of human tissue – is checked for sterility. A gripper arm then transports the biopsy into the automated device where the individual steps are performed: The machine cuts the biopsy into small pieces, isolates the different cell types, stimulates their growth, and mixes the skin cells with collagen. A three-dimensional reconstruction of the different skin layers is produced with the aid of a special gel matrix – and the skin is ready. In the final step, the machine packages the cells for shipment.

Alternatively, the tissue can be cryopreserved – that is, deep-frozen and stored for later use. "It was important for us that the entire mechanical process is divided into separate modules," says Mertsching. "This enables us to replace or modify individual modules, depending what is needed for the production of different tissue types." The method opens up almost unlimited new possibilities for the medical scientists.

Adapted from *Science Daily*

1 Answer the following questions in about 10 lines. Use your own words as far as possible.

1. Why is the research conducted in Stuttgart innovative?
2. Explain the automated process and its advantages.