Media release

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New process for manufacturing nanocellulose

Using nanocellulose to create novel composite materials

For some time now nanocellulose has been at the focus of a good deal of industrial and scientific interest as a novel biomaterial. Potential applications range from the creation of new kinds of commercially useful materials and uses in medical technology all the way to the food and pharmaceutical industries. Empa researchers have now developed a manufacturing process for nanocellulose powder, the raw material for creating polymer composites which can be used, for example, in lightweight structures for the car industry or as membrane and filter material for biomedicinal applications.

Cellulose is a biopolymer consisting of long chains of glucose with unique structural properties whose supply is practically inexhaustible. It is found in the cell walls of plants where it serves to provide a supporting framework – a sort of skeleton. Cellulose is extremely strong in tension and can be chemically modified in many ways, thereby changing its characteristics. It is also biodegradable. In the search for novel polymer materials with certain desirable characteristics material scientists have developed such substances as high performance composites in which nanofibers of cellulose are embedded. In the form of lightweight structural material, these composites have similar mechanical properties to steel, while as nanoporous "bio"-foam they provide an alternative to conventional insulating materials.

The ideal lightweight structural material

Classical cellulose chemistry on the industrial scale is primarily used in the wood pulp, paper and fiber industry. Commercial research is currently focused on isolating and characterizing cellulose in the form of nanofibers. So-called nanocellulose consists of fibers or crystals with a diameter of less than 100 nm. Material scientists hope to be able to use nanocellulose to create new lightweight materials boasting high mechanical strength – in short the ideal material for creating lightweight structures.

The cellulose experts in Empa's Wood Laboratory isolated cellulose nanofibers from wood pulp. These are several micrometers long but only a few nanometers thick and are closely interlinked. The fibers have an extremely large surface area on which chemical-physical reactions with substances such as water, organic and

inorganic chemicals and polymer compounds can occur. Cellulose nanofibers can therefore be used as stable, extremely reactive raw materials for technical applications while boasting the additional advantages of being biologically produced and biodegradable. Such applications include reinforcing (bio-)polymers to create very promising, environmentally safe, lightweight construction material for the car industry, as well as membrane or filter materials for applications in packaging and biomedicine.

The solution lies in chemical modification

Nanocellulose isolated from wood pulp is initially in the form of a water-based suspension. If the material dries out the cellulose fibers stick together forming rough clumps and it loses its outstanding mechanical properties. For this reason the Empa researchers sought to develop a process which allowed them to dry nanocellulose without it clumping and becoming rough. To achieve this, the cellulose was treated using a technique which is easily implemented on a large scale and is also completely harmless, even being suitable for applications in the food industry. The method prevents the cellulose fibrils from forming clumps and sticking together

The results are worth looking at: after being re-dispersed in water the dried nanocellulose powder boasts the same outstanding properties as undried, unmodified cellulose. This makes the new product an attractive alternative to conventional cellulose suspensions for the synthesis of bio-nanocomposite materials. Suspensions currently in use consists of over 90% water which causes the transport costs to explode and increases the danger of degradation by bacteria or fungi. In addition aquatic cellulose suspensions are laborious to work with since usually in the course of chemical processing solvents must be exchanged.

Empa Research Prize 2011 goes to Christian Eyholzer

The work on developing the new manufacturing process and identifying applications for nanocellulose in various biopolymers was recently recognized with the award of the Empa Research Prize 2011. In a collaborative project with the «Luleå University of Technology», Sweden, Empa researcher and PhD student Christian Eyholzer and his co-workers used the novel nanocellulose powder to reinforce adhesives, hydrogels and biodegradable synthetics. After completing his doctoral dissertation Eyholzer left Empa and is currently employed by Sika as project leader in the product development department.
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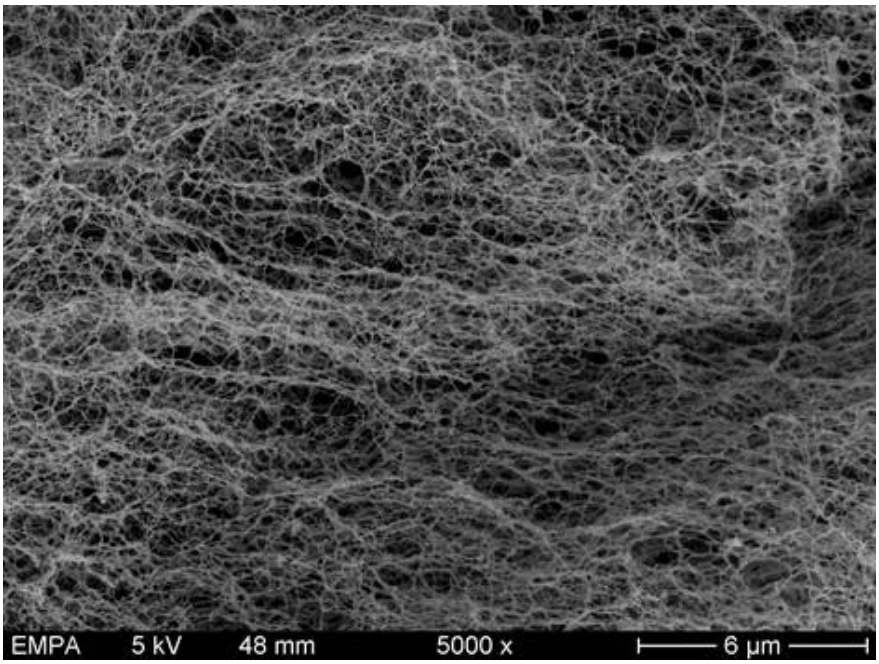

A scanning electron microscope image of chemically modified, nanofibrillized cellulose.

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