Nanostructured rubber-like material with optimal properties could replace human tissue

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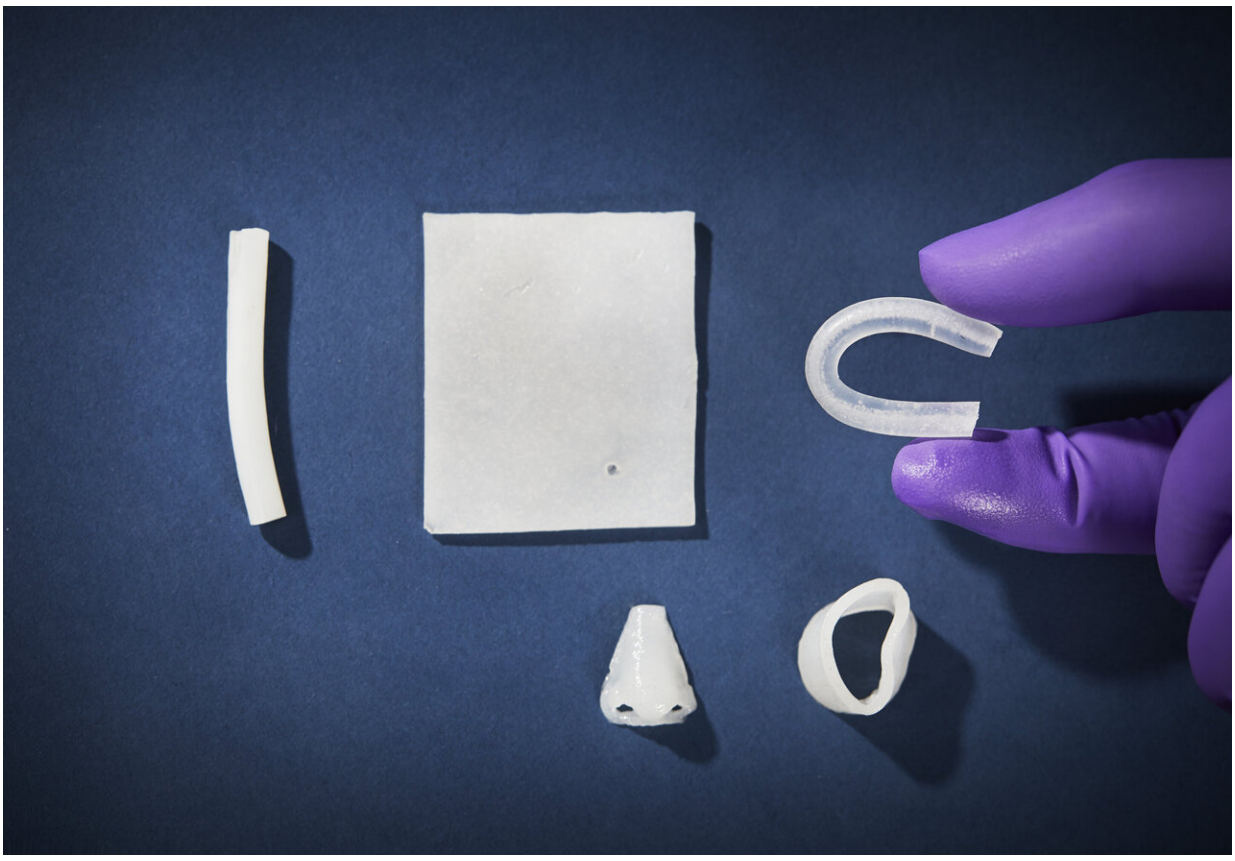


Researchers at Chalmers have developed a new synthetic rubber-like material with a unique combination of properties. The material could be suitable for applications in various medical devices for supporting or replacing human tissue. The 3D printed 'nose' in the image is an example of how the material could act as a possible replacement for cartilage. Credit: Anna Lena Lundqvist/Chalmers

Researchers from Chalmers University of Technology, Sweden, have created a new, rubber-like material with a unique set of properties that could act as a replacement for human tissue in medical procedures. The material has the potential to make a big difference to many people's lives. The research was recently published in the highly regarded scientific journal *ACS Nano*.

In the development of medical technology products, there is a great demand for new naturalistic materials suitable for integration with the body. Introducing materials into the body comes with many risks, such as serious infections, among other things. Many of the substances used today, such as Botox, are very toxic. There is a need for new, more adaptable materials.

In the new study, the Chalmers researchers developed a material consisting solely of components that have already been shown to work well in the body.

The foundation of the material is the same as plexiglass, a material used in many medical technology applications. By redesigning its makeup, and through a process called nanostructuring, the researchers gave the material a unique combination of properties. Their initial intention was to produce a hard, bone-like material, but they had unexpected results.

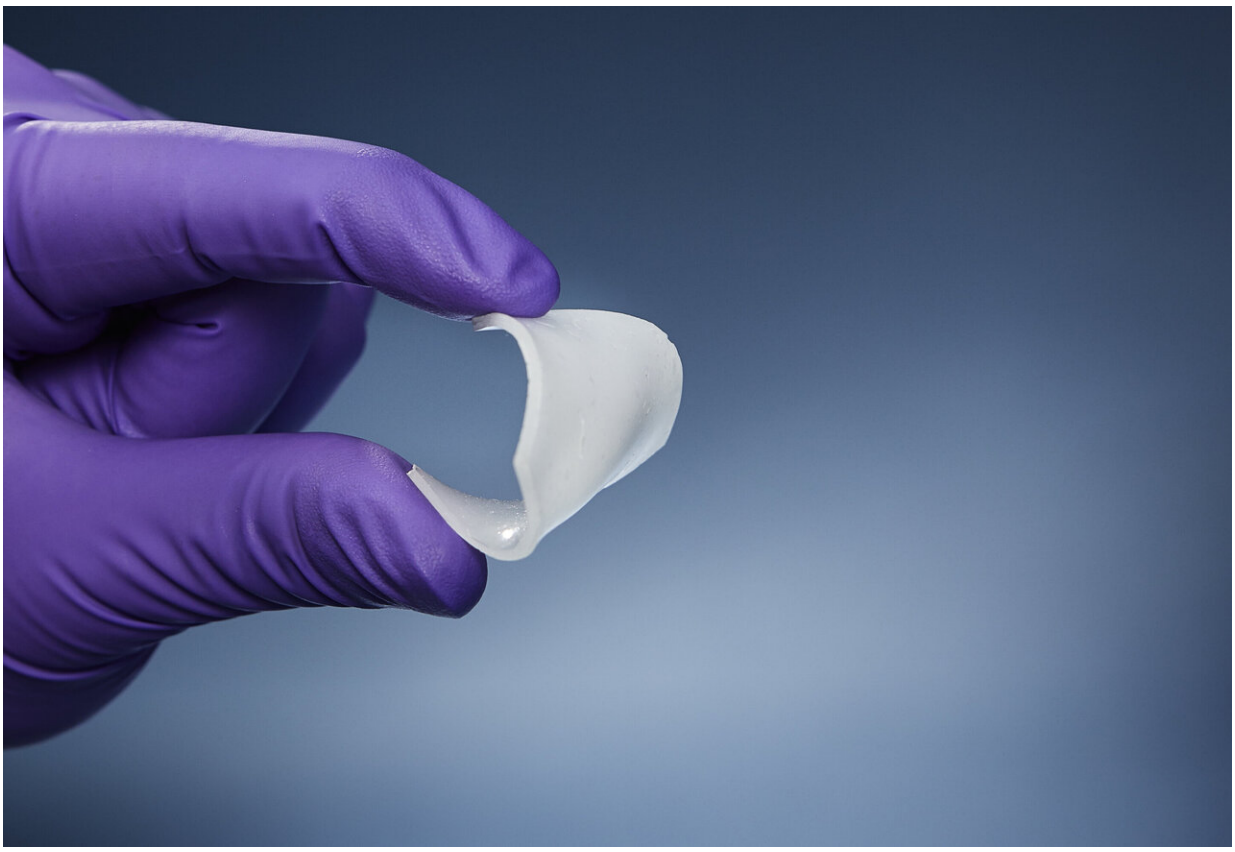
"We were really surprised that the material turned out to be very soft, flexible and extremely elastic. It would not work as a bone replacement material, we concluded. But the new and unexpected properties made our discovery just as exciting," says Anand Kumar Rajasekharan, Ph.D. in Materials Science and one of the researchers behind the study.

The results showed that the new rubber-like material may be appropriate for many applications that require an uncommon combination of properties—high elasticity, easy processability, and suitability for

medical uses.

"The first application we are looking at now is urinary catheters. The material can be constructed in such a way that prevents bacteria from growing on the surface, meaning it is very well suited for medical uses," says Martin Andersson, research leader for the study and Professor of Chemistry at Chalmers.

The structure of the new nano-rubber material allows its surface to be treated so that it becomes antibacterial, in a natural, non-toxic way. This is achieved by sticking antimicrobial peptides—small proteins that are part of the innate immune system—onto its surface. This can reduce the need for antibiotics, an important contribution to the fight against growing antibiotic resistance.



The foundation of the material is the same as plexiglass, a material which is common in medical technology applications. Through redesigning its makeup, and through a process called nanostructuring, they gave the newly patented material a unique combination of properties, incuding high elasticity, as demonstrated in the image. Credit: Anna Lena Lundqvist/Chalmers

Because the new material can be injected and inserted via keyhole surgery, it can also help reduce the need for drastic surgery and operations to rebuild parts of the body. The material can be injected via a standard cannula as a viscous fluid, so that it forms its own elastic structures within the body. Or the material can also be 3-D printed into specific structures as required.

"There are many diseases where the cartilage breaks down and friction results between bones, causing great pain for the affected person. This material could potentially act as a replacement in those cases," Martin Andersson continues.

A further advantage of the material is that it contains three-dimensionally ordered nanopores. This means it can be loaded with medicine for various therapeutic purposes such as improving healing and reducing inflammation. This allows for localized treatment, avoiding, for example, having to treat the entire body with drugs, something that could help reduce problems associated with side effects. Since it is non-toxic, it also works well as a filler—the researchers see plastic surgery therefore as another very interesting potential area of application for the new material.

"I am now working full time with our newly founded company, Amferia, to get the research out to industry. I have been pleased to see a lot of real

interest in our material. It's promising in terms of achieving our goal, which is to provide real societal benefit," Anand concludes.

More information: Anand K. Rajasekharan et al, Tough Ordered Mesoporous Elastomeric Biomaterials Formed at Ambient Conditions, *ACS Nano* (2019). DOI: 10.1021/acsnano.9b01924

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