Optoacoustic sensor measures water content in living tissue

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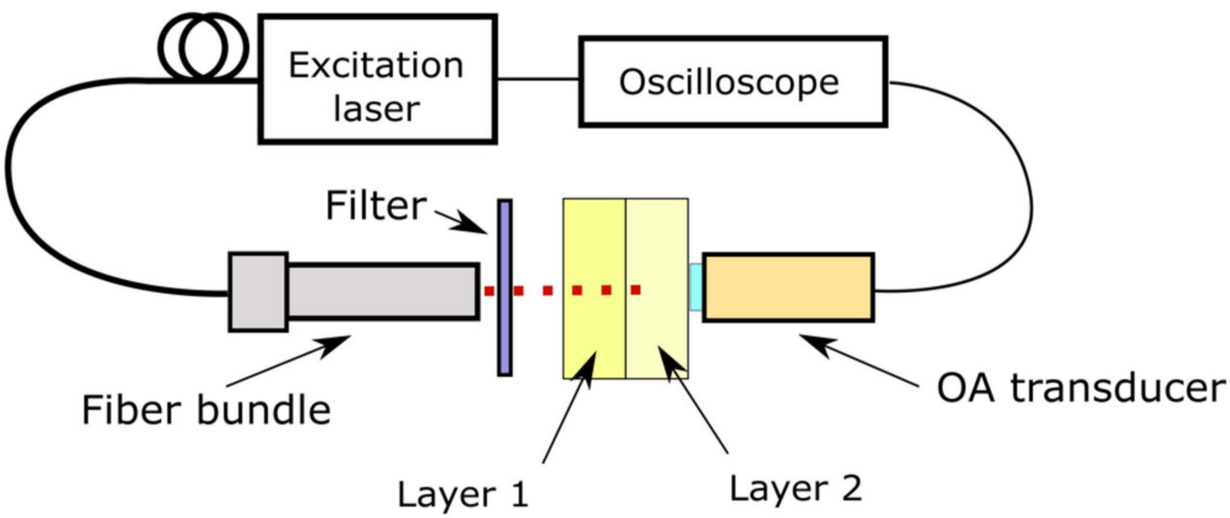

Too much or too little water in skin tissues can be a sign of various health problems, such as an edema. Credit: Skolkovo Institute of Science and Technology

Researchers from Skoltech and the University of Texas Medical Branch (US) have shown how optoacoustics can be used for monitoring skin water content, a technique which is promising for medical applications such as tissue trauma management and in cosmetology. The paper outlining these results was published in the *Journal of Biophotonics*.

(swelling caused by fluid accumulation) or dehydration, which can also have cosmetic impacts. Right now, electrical, mechanical and spectroscopic methods can be used to monitor water content in tissues, but there is no accurate and noninvasive technique that would also provide a high resolution and significant probing depth required for potential clinical applications.

Sergei Perkov of the Skoltech Center for Photonics and Quantum Materials and his colleagues decided to test whether the optoacoustic method can be used for this purpose. In optoacoustic monitoring, tissue is irradiated with pulsed light, which causes thermoelastic expansion of the target that absorbs this light, and that target can be detected in ultrasound signals. In previous studies, optoacoustic spectroscopy has been shown to detect hemoglobin, melanin, and water, and the team decided to find out whether this method can be used both on tissue models and in vivo on real skin.

"The OA technique is safe for clinical applications because the amount of energy absorbed by the biological tissue that is required for signal detection is relatively small. The advantage of OA technique over other optical methods is that we need to deliver laser energy only in one direction—to the absorber, and after that we detect a generated ultrasound signal that does not attenuate much in biological tissues, whilst in order to detect the signal using optical methods, a light beam has to propagate to the absorber and back (or through the whole body part)," Dmitry Gorin, a Skoltech professor and coauthor of the paper, says.

The researchers built two-layered "skin phantoms" out of gelatin and milk and constructed some of them to mimic swelling under the top "epidermis" layer, using water. They also tested their optoacoustic detector on human wrists with no edema. The data they got was in good agreement with earlier published data on skin water content, and the team was able to identify optimal wavelengths for water content monitoring.

Next, the team plans to conduct similar experiments in vivo on real edema and to increase the number of different wavelengths used for OA signal generation in order to try to quantify the amount of water in different layers of the skin. This work will continue in collaboration with UTMB Galveston professor Rinat Esenaliev.

More information: Sergei A. Perkov et al. Optoacoustic monitoring of water content in tissue phantoms and human skin, *Journal of Biophotonics* (2020). DOI: 10.1002/jbio.202000363

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