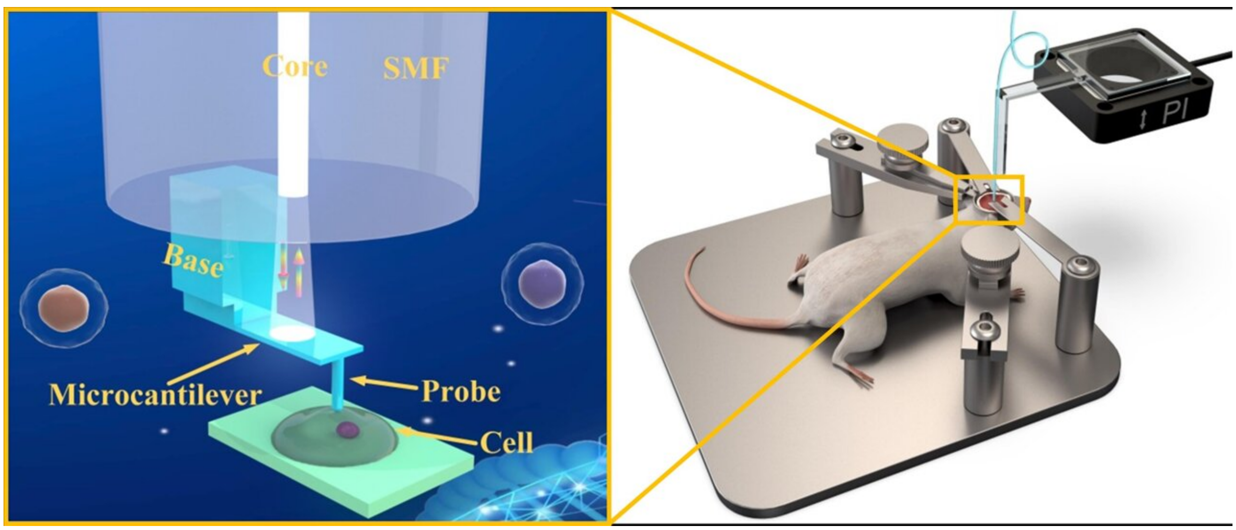
Scientists invent 3D printed fiber microprobe for measuring in vivo biomechanical properties of tissues

February 10 2023



Fiber optical nanomechanical probe (FONP) fabricated by femtosecond laser two-photon polymerization technology can realize the biomechanical measurement down to 2.1 nanonewton. Such high precision enables the measurement of in vivo biomechanical properties of tissue, single cell, and other soft biomaterials. Credit: *International Journal of Extreme Manufacturing* (2023). DOI: 10.1088/2631-7990/acb741

Fiber sensing scientists at Shenzhen University have developed a compact fiber optical nanomechanical probe (FONP) for measuring in vivo biomechanical properties of tissue and even single cells.

Publishing in the journal *International Journal of Extreme Manufacturing*, the researchers from Shenzhen University applied femtosecond laser-induced two-photon polymerization technology to fabricate a fiber-tip microprobe with ultrahigh mechanical precision down to 2.1 nanonewton.

This high-precision mechanical sensing system enables the measurement of in vivo biomechanical properties of tissue, single cell, and other types of soft biomaterials. The findings could have a widespread impact on the future development of all-fiber Atomic Force Microscopy for biomechanical testing and nanomanipulation.

One of the lead researchers, Professor Yiping Wang, commented, "The biomechanical properties of different tissues in the human body range widely with seven orders of magnitude, from the softest cells to the stiffest bones. We have developed a flexible strategy that could design and fabricate the fiber-tip microprobes with the most fitted spring constant for the accurate in vivo biomechanical measurement of almost all the tissues in the human body."

Atomic Force Microscopy (AFM) is one of the few technologies that could perform delicate biomechanical measurements. However, there are typical limitations of bench-top AFM system in its size and complex feedback system. It also requires certain geometry of the samples to be measured, which further limits its application in biomechanical measurement in vivo.

First author Dr. Mengqiang Zou claimed, "Our work achieved a new generation of all-fiber AFM with the flexible methodology to achieve the best design of the fiber-tip microprobe for every in vivo test, which was turned out to be reliable and also much more miniaturized."

Professor Changrui Liao has pioneered fiber-tip microdevices fabricated by femtosecond laser-induced two-photon polymerization technology for gas sensing. Here his group has developed the technology to achieve various fiber-tip microstructures, specifically in terms of microcantilevers with additional topological design, to achieve microprobes with a series of spring constants.

This development allows the "all-fiber AFM" to become a next-generation tool for basic research involving the in vivo biomechanical measurement of various types of tissues.

The team utilized the finite element method and topological theory to optimize the design of fiber-tip microcantilever probes. The finest microprobe could reach a reliable measuring capability down to 2.1 nanonewton.

Professor Sandor Kasas said, "This is a milestone achievement and it is only the beginning. We anticipate this technique to become a powerful tool for in vivo biomechanical study of human tissue and cells, to further understand the fundamentals of biomechanical changes related with diseases such as cancer, and also in the critical processes of developmental biology."

More information: Mengqiang Zou et al, 3D printed fiber-optic nanomechanical bioprobe, *International Journal of Extreme Manufacturing* (2023). DOI: 10.1088/2631-7990/acb741

Provided by International Journal of Extreme Manufacturing