New fluidic system advances development of artificial blood vessels and biomedicine applications

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A VasFluidic system with multi-branch channels, and the channels perfused with liquid inside. Credit: *Nature Communications* (2024). DOI: 10.1038/s41467-024-45781-3

Nature consistently inspires engineering applications. Recently, a group of researchers from the Faculty of Engineering at the University of Hong Kong (HKU) drew new inspiration from the vascular network and developed a new type of fluidic system named VasFluidics.

The fluidic system can modulate fluid compositions via spatially different reactions between fluids and channel walls, something that has not yet been realized in traditional fluidic systems.

This work was conducted by the research team of Professor Anderson Ho Cheung Shum's Microfluidics and Soft Matter Team in the Department of Mechanical Engineering of the Faculty of Engineering.

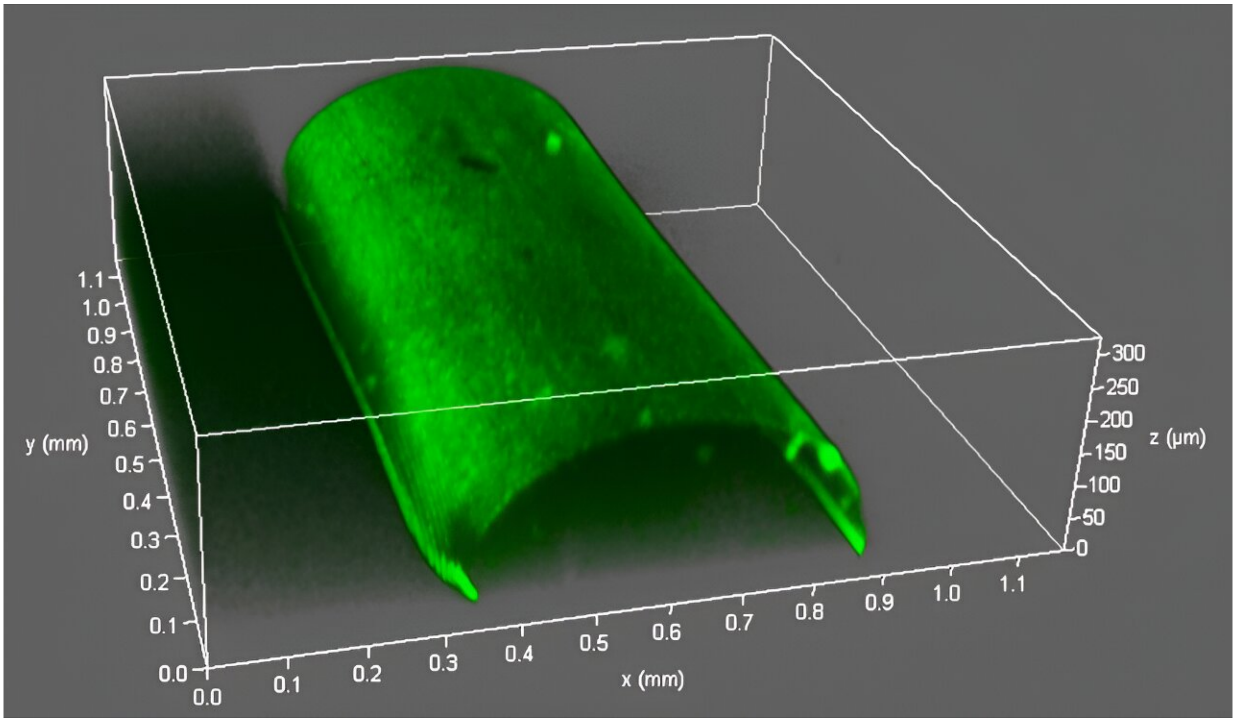
Their discovery has been published in *Nature Communications*, titled "Vascular network-inspired fluidic system (VasFluidics) with spatially functionalizable membranous walls."

"The brilliant control over blood compositions in vessels is remarkable and essential, inspiring us to think about how to design new fluidic systems," said Yafeng Yu, the first author of the research project.

The blood vascular network, a natural fluidic system, inspired the research. Guided by the vascular network, Professor Shum's team developed VasFluidics, a fluidic system with functionalizable membrane walls. Similar to blood vessel walls, the walls of VasFluidic channels are thin, soft, and capable of changing liquid compositions via physical or chemical means.

This study demonstrates the power of VasFluidics in fluid processing. After separated channel regions are deposited with solutions or coated with enzymes, some regions of the VasFluidic channels physically allow specific molecules to pass through the channel walls, while some chemically change liquid compositions. The results are reminiscent of glucose adsorption and metabolism processes in the human body.

"VasFluidics is quite different from the traditional fluidic systems. Channel walls of traditional devices are typically impermeable, and cannot work like real tissues to 'communicate' with fluids inside or outside the channel for fluid modulation," Yafeng Yu explained.



3D image of a VasFluidic channel (laser confocal scanning microscope image). Credit: *Nature Communications* (2024). DOI: 10.1038/s41467-024-45781-3

The reported technique combines 3D printing and self-assembly of soft materials. The research group prints one liquid within another immiscible liquid, assembling soft membranes on the liquid-liquid interface. Besides microfluidics-related research, Professor Shum's group also focuses on soft material assembly on the liquid interface. The theoretical and experimental basis of soft materials in their previous research paves the way for fabricating VasFluidic devices.

"VasFluidics has promising applications, especially for designing microtubule structures and bioinks. So it has great potential to be combined with cell engineering to develop artificial blood vessel models, which are expected to be used in biomedical applications, such as organ-on-chip and organoids," said Dr. Yi Pan, a contributor to this research, previously a Ph.D. student in Professor Shum's group, and currently an Associate Professor of the College of Medicine at the Southwest Jiaotong University.

Dr. Wei Guo, another contributor to this research and a research assistant professor in Professor Shum's group, added, "Apart from the scientific merits and potential biomedical applications of this work, it also sparks our imagination. The vascular tissue of the human body, an efficient transport system, has been refined over millions of years of evolution.

"By demonstrating the potential of synthetic systems like VasFluidics to reconstruct vascular tissue, this research represents a substantial advancement in our efforts to mimic and harness the extraordinary capabilities of nature's most precise and efficient systems."

Professor Shum's team has been focusing on cutting-edge microfluidic techniques to push the envelope in precise (bio)liquid control and efficient (bio)liquid sample analysis. Despite their progress in microfluidics-assisted biomedical applications, the research team refused to just settle on the traditional setups.

By exploring and realizing the potential of microfluidics for more efficient biofluid processing and analysis, the team realizes that new paradigms in designing and fabricating fluidic devices are needed.

"Our long-term goal is to utilize microfluidics to develop ultra-sensitive analysis of human body fluids, to assist precision medicine against diseases, and to benefit human health," Professor Shum said.

Professor Shum foresees that the VasFluidics system will pioneer biomimetic platforms with complex fluid manipulation. "Potential biomedical applications are boundless. Examples are in-vitro modeling of biological fluid mechanics, biomolecule synthesis, drug screening, and disease modeling in organ-on-chips," he said.

More information: Yafeng Yu et al, Vascular network-inspired fluidic system (VasFluidics) with spatially functionalizable membranous walls, *Nature Communications* (2024). DOI: 10.1038/s41467-024-45781-3

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