Liquid metal key to simpler creation of electrodes for microfluidic devices

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Researchers from North Carolina State University have developed a faster, easier way to create microelectrodes, for use in microfluidic devices, by using liquid metal. Microfluidic devices manipulate small amounts of fluid and have a wide variety of applications, from testing minute blood samples to performing advanced chemical research.

"By making it easier to incorporate electrodes into microfluidic devices, we hope to facilitate research and development into new technologies that utilize those devices, such as biomedical tools," says Dr. Michael Dickey, an assistant professor of chemical and biomolecular engineering at NC State and co-author of a paper describing the research.

Traditionally, microfluidic devices have incorporated solid metal electrodes that serve as sensors, pumps, antennas or other functions. However, these solid electrodes can be problematic, because they need to be physically aligned to a channel that runs through the device. The channel serves as the entry point for whatever fluid the device is designed to manipulate. Aligning the electrodes is tricky because the electrodes are only tens to hundreds of microns in diameter, as is the channel itself. It is difficult to manipulate objects of that size – a micron is one-millionth of a meter, and a human hair is approximately 100 microns in diameter.

The NC State team has addressed the problem by designing microfluidic devices that incorporate three channels, with the central channel separated from the other two by a series of closely set posts. The

researchers inject the two outer channels with a liquid metal alloy composed of gallium and indium. The alloy fills the outer channels completely, but forms an oxidized "skin" that spans the space between the posts – leaving the central channel free to receive other fluids.

"This approach allows you to create perfectly aligned electrodes in a single step," Dickey says. "The channels are built into the device, so the electrodes are inherently aligned – we get the metal to go exactly where we want it. This means creating these devices is easier and faster."

In addition, this approach allows for the creation of electrodes in useful configurations that were previously difficult or impossible to achieve. This can be done by changing the shape of the channels that will be injected with the liquid metal. These configurations would create more uniform electric fields, for use in manipulating fluids and particles.

More information: The paper, "Inherently aligned microfluidic electrodes composed of liquid metal," was co-authored by Dickey and NC State Ph.D. student Ju-Hee So. The paper is forthcoming from the Royal Society of Chemistry's journal *Lab on a Chip*.

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