Portable instrument that replaces full-size laboratory provides accurate multi-element analysis in less than a minute

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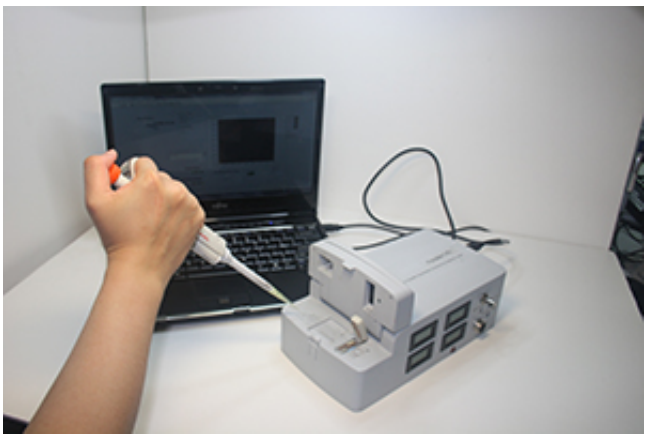

Analyses of liquid samples that once required a full-sized laboratory can now be completed on a disposable plastic chip equipped with narrow fluidic channels and tiny sensors. Credit: A*STAR Institute of Materials Research and Engineering

Engineers from the A*STAR Institute of Materials Research and Engineering and colleagues at the University of Basel, Switzerland, have designed and developed a compact, portable analytical instrument that can detect multiple ions and molecules down to a level of 300 parts per billion (ppb) in less than a minute. The machine, based on lab-on-a-chip technology, needs only drop-sized liquid samples. The analysis is very quick, precise and sensitive, and can be performed remotely as no direct

contact with the solution is necessary. As such, the device has widespread potential applications in the water, food and beverage, agriculture, environmental, pharmaceutical and medical industries.

"The instrument is now ready for commercialization," says Kambiz Ansari, who led the research. "In this well-studied field, it is one of only a handful of actual lab-on-a-chip instruments reported so far."

The easy-to-operate machine, which weighs only 1.2 kg, combines microchip electrophoresis (MCE) with a sensing technology known as a dual capacitively-coupled contactless conductivity detector (dC^4D). The system first uses electrophoresis to separate ions and then detects the ions using dC4D. All analyses are performed in microfluidic channels consisting of capillaries inside polycarbonate plastic chips that are narrower than a human hair.

The beauty of the dC^4D technology is its simplicity: it relies on remote conductivity measurements via a pair of electrodes. One electrode sends radio-frequency signals through a channel to the second electrode, and the signal received is read by a computer. Because the ions have charge, their resistance drops as they pass through the microfluidic channel, resulting in sudden peaks. Specially designed software then analyzes the data to provide both qualitative and quantitative information.

The instrument has two access compartments (see image). The front compartment houses a plastic chip and a replaceable cartridge detector for the testing; both are designed to eliminate noise. The back compartment houses the electronics and software, the data acquisition card and a battery that powers the instrument for up to 10 hours.

The researchers tested the instrument's capability to measure inorganic ions in water, rabbit blood and human urine, as well as organic and inorganic acids in fruit juice. They assessed its accuracy against standard

methods.

"We have been approached about licensing the technology by several companies active in clinical analyses and in the ornamental fish farm industry," Ansari says. "And, we are hoping to further develop our system to achieve detection levels lower than 1 ppb by pre-concentrating the samples; we are also planning to introduce nanofluidics into the dC^{4}D system."

More information: Ansari, K., Ying, J. Y. S., Hauser, P. C., de Rooij, N. F. & Rodriguez, I. "A portable lab-on-a-chip instrument based on MCE with dual top–bottom capacitive coupled contactless conductivity detector in replaceable cell cartridge." *Electrophoresis* 34, 1390–1399 (2013). dx.doi.org/10.1002/elps.201200592

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