Researchers report novel collision-based computing technique

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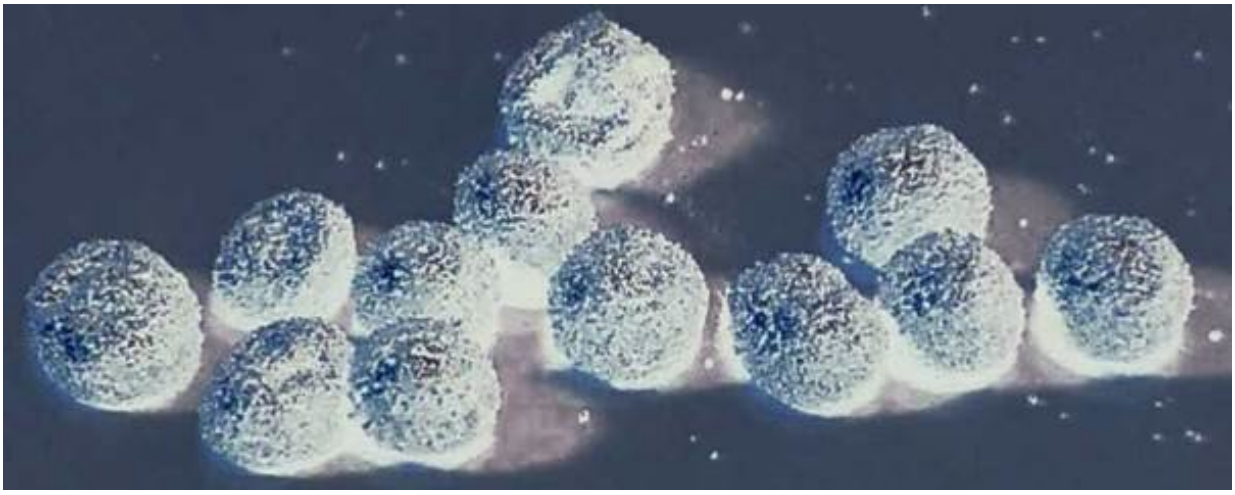

Credit: University of the West of England

Researchers have published a paper that demonstrations the first laboratory experiment to use liquid marbles to create collision-based computation in research.

The paper, titled "Liquid Marble Interaction Gate for Collision-Based Computing" is published by Elsevier in *Materials Today*. The research is led by Professor Andy Adamatzky and Dr Ben De Lacy Costello.

Liquid marbles (LMs) are liquid droplets that are encapsulated in a coating of hydrophobic particles (i.e. that don't like water), such as

powdered metal or other materials. When coated, the droplets are self-enclosed and can be used to move around or manipulate very small volumes of liquid (10 microliters), while the reactions are compartmentalised in the droplets.

Dr Ben De Lacy Costello explains the liquid marbles, "How do we move a drop of water from one place to the other? Aphids have developed their own method – they produce a sugary solution that they coat in a sticky wax, which enables them to be move the liquid around.

"Scientists using microfluidics for medical applications usually treat the surface to make it hydrophobic so that the water droplets move freely across the surface, but other scientists working with this technology treat the drops themselves, similar to aphids, by covering them in hydrophobic particles-creating liquid marbles."

Researchers at the University of the West of England, (UWE Bristol) working in Unconventional Computing have experimented with LMs as a method of computation, as part of their research developing methods of information processing and computing in physical, chemical and biological systems.

Professor Andy Adamatzky explains, "We wondered could these ball-like objects could be used for physical computation by making them collide with each other, so we could make proper circuits? Inspired by computing concepts that involve colliding spheres, our research aims to make physical computers based on liquid marbles. This approach allows marbles to be delivered to specific locations by controlled collisions between the marbles.

"This is important because these marbles are delivering a chemical or even biological cargo. Our collision based computing schemes control what happens to the cargo, for example some high velocity collisions

cause marbles to fuse and the contents to mix with the possibility of starting reactions and making new products, other collisions just guide the single marbles to their final destinations."

The team used the LMs to create an experiment in collision-based computing, using the intersection of the LMs as a logic gate. LMs with an electromagnetic coating were set up to move in a framework and when they collided a computation occurred. The LMs are given information values and where a signal interacts this is a logic gate – similar to the logic functions inherent in conventional computing.

Professor Adamatzky says, "Our experiment demonstrates the potential to create alternative forms of computing using the LMs to create logic gates. The computing devices we made with LMs are completely mechanical, and have the benefits of not requiring any specialised knowledge to operate. The prototypes are will be simple, durable and inexpensive to manufacture."

While still at a very early stage, this experiment demonstrates the capacity for an entirely new form of computation, which uses the innate abilities of materials to make computational decisions.

More information: Thomas C. Draper et al. Liquid marble interaction gate for collision-based computing, *Materials Today* (2017). DOI: 10.1016/j.mattod.2017.09.004

Provided by University of the West of England