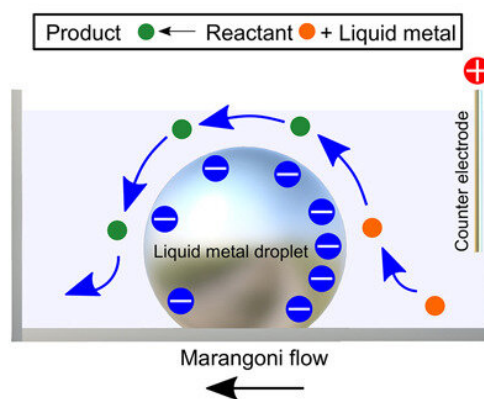
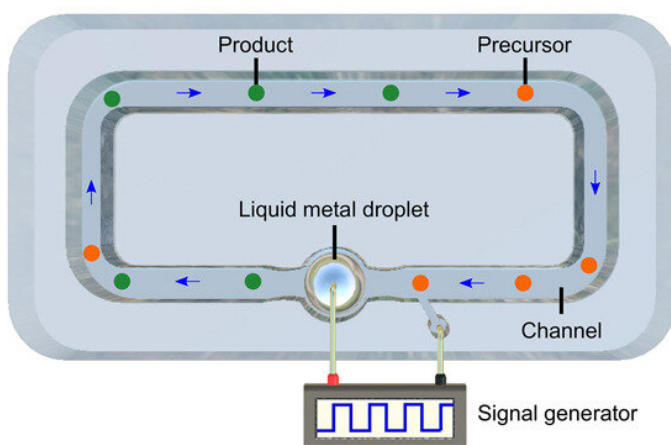
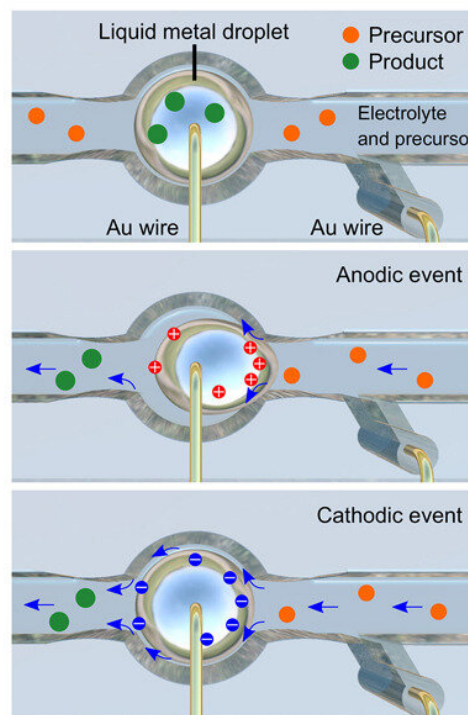
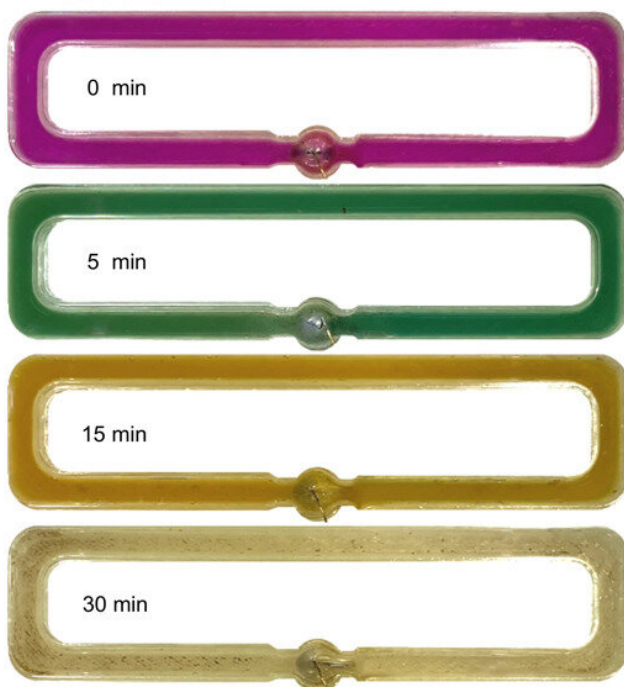


No more moving parts: Liquid metal enabled chemical reactors

November 15 2021



Production of Mn_3O_4



Graphical abstract. Credit: DOI: 10.1016/j.matt.2021.10.022

Liquid-metal machines could wipe out maintenance issues for continuous flow reactors.

Metals that are liquid at room temperature, such as gallium and its alloys, are attractive materials due to their unique electrical, thermal and fluidic properties.

In a study published today, a research team led by UNSW, Sydney has shown that liquid metals can offer their characteristics to the pharmaceutical and chemical industries, with the possible elimination of moving parts in continuous [flow](#) reactors providing improved performance and reduced maintenance costs.

Traditional mechanical pumps and moving parts could potentially be replaced by 'soft' components that literally never failed in the life of the machine.

Zero moving parts for better flow reactors

Flow reactors are being increasingly adopted in pharmaceutical and chemical industries, with their operation and maintenance representing an important factor in these industries.

Continuous flow reactors allow fast reactions, offer safe control, and enable easy scaling-up opportunities. More than ever these industries are inclined to implement flow reactors for increasing [product quality](#) and yield of chemical and biochemical reactions.

However, one of the most important technological issues is with the core

components of such reactors, which generally use moving parts, which can be fouled, blocked, and broken via precipitation of materials, hence compromising the productivity and longevity of the systems.

One possibility to overcome such drawbacks, while keeping the functionalities of the continuous flow reactor, is replacing the traditional mechanical pumps and moving parts with soft and never-failing components.

Liquid metals exhibit the potential to design continuous flow reactors as their low melting point, non-toxicity, controllable shape, and reactive surface offer what efficient and durable flow reactors require.

Interestingly, the flow formed around the liquid metal reactive core, called Marangoni flow when an external voltage is applied, eliminates the need for moving parts and relies instead on surface tension to do the pumping of the flow.

Additionally, the active surface of the liquid metal facilitates chemical reactions.

Thus, the liquid metal simplifies the continuous flow reactor design, and it plays two critical roles in the system for material synthesis and also for mass transport.

In a recent work published in the journal *Matter*, the researchers from UNSW, and their collaborators from Queensland University of Technology (QUT), Australia, and University of California, Los Angeles (UCLA), U.S., demonstrated a continuous flow reactor enabled by liquid metal droplets in their cores.

The team introduced three different model examples into the reactor to produce three popular functional materials:

- manganese oxide, which is widely utilized for the synthesis of soft ferrites
- graphene, which is used in many applications such as those in water purification and energy storage/conversion, and
- molybdenum sulfide, which is known for its new applications in microelectronics.

The system showed versatile capabilities for generating materials with tuneable system performance and controlled material quality.

"The liquid metal can be easily integrated into a fluidic channel for constructing the continuous flow reactor," said Mr Jialuo Han, the first author of the work. He added "The liquid [metal](#) itself can spontaneously produce materials on the surface and the material is repelled away from its surface with the application of an external voltage."

"This proof-of-concept continuous flow [reactor](#) is enabled by a single droplet of [liquid metal](#), which can be extended for synthesizing many different valuable materials with high-quality control," said Dr. Mohannad Mayyas, a corresponding author of this study. "It has no mechanical parts and can in principle be readily scaled up for future commercialization."

More information: Jialuo Han et al, Liquid metal enabled continuous flow reactor: A proof-of-concept, *Matter* (2021). [DOI: 10.1016/j.matt.2021.10.022](#)

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