Research team invents novel light-controlled contamination-free fluidic processor

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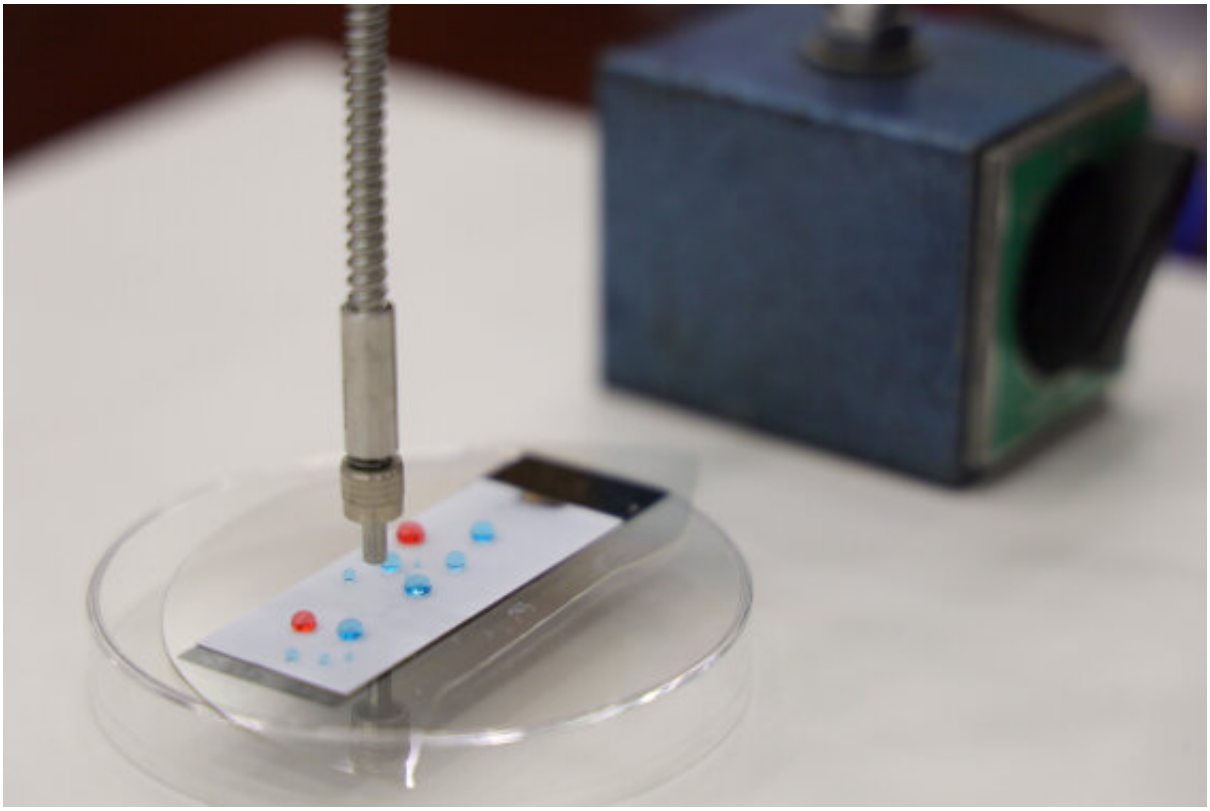


Demonstration of the light-controlled contamination-free fluidic processor. Credit: The University of Hong Kong

A mechanical engineering research team at the University of Hong Kong (HKU) has invented a novel light-controlled, contamination-free fluidic processor, which can serve as a useful tool to greatly reduce the risk of infection of front-line medical workers in testing virus or bacteria in big

pandemics like the current COVID-19 pandemic, and to minimize the risk of contamination during the process.

The new technology has been published in *Science Advances* in an article titled "Photopyroelectric Microfluidics," co-authored by graduate student Mr Wei Li, postdoctoral researcher Dr. Xin Tang and Chair Professor Liqiu Wang at the Department of Mechanical Engineering, Faculty of Engineering, HKU.

Precision manipulation of various liquids is essential in many fields. The team innovatively uses light as a stimulating force, allowing contactless manipulations in moving, merging, dispensing and splitting liquids, on a specifically designed photo-responsive platform. The platform is non-toxic and non-sticky to all fluids, making it an ideal contamination-free fluidic processor.

Professor Wang said the first applications of the new technology can be in biomedical testing and diagnosis, with the aim of lowering the risk of contamination and infection in the process.

"Testing infectious viruses and bacteria is highly risky, sometimes even fatal. A blood droplet from an Ebola patient can infect medical workers through the skin. For diagnosis, medial workers have to crash, filter and purify a patient's blood sample to obtain the virus's genetic materials. This series of operations, very often in a fluidic medium, is highly infectious. Moreover, fluids stick to surfaces, which will contaminate containers and handling tools, causing potential dangers if the medical wastes are not properly managed." He said.

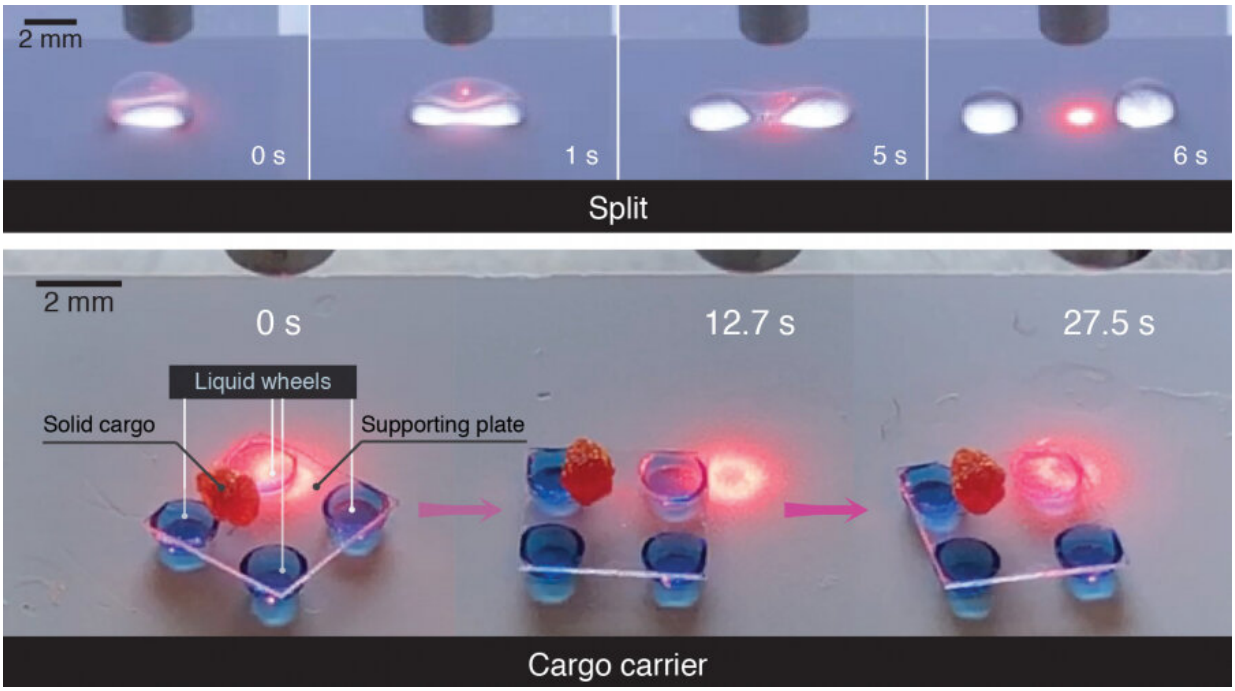
According to WHO reports, healthcare workers are 21 to 32 times more likely to be infected with Ebola and nearly 14% of COVID-19 reported cases are among healthcare workers. Moreover, it is estimated that disposable plastics worth US$20 billion are consumed in testing

annually. The used plastics are left with potentially infectious or toxic residues and hazardous wastes that cost another US$10 billion to handle.

"We hope the newly-invented technique can reduce and even replace the usage of disposable plastics in the biomedical and pharmaceutical industries. The light-control device outperforms its electrical counterpart in the market in terms of operational precision and convenience, whereas the cost is only one-hundredth of it." Professor Wang said.

The key technology of the light-controlled fluidic processor is a two-layer photo-responsive platform. With a thickness of only 2mm, it is portable and easy to handle. Its superomniphobic surface interfaces fluids in a frictionless manner, like dew drops rolling on a lotus leaf; and a photothermal pyroelectric layer, which senses the light stimuli and converts it into a force that move, split and dispense fluids.

It has great potential in advanced research and applications in DNA analysis, proteomics, cell assay and clinical diagnosis, chemical synthesis and drug discovery. It can handle a wide spectrum of liquids such as water, alcohol, alkanes, and particularly silicone oil, which is particularly challenging because of its ultra-low surface tension. Its maneuverable fluid volume can be from 1000 μl to tiny droplets at 0.001 μl, i.e. about 0.02% of the volume of blood in a mosquito bite, which is 100 times smaller than that manipulated by its electrical counterpart.



(upper photos) showing the split of an ethanol droplet by a beam of light on the photopyroelectric microfluidic platform.(below) showing a light-controlled cargo carrier with droplet wheels transporting a solid cargo. Credit: The University of Hong Kong

"The device functions as a 'magic' wetting-proof hand to navigate, fuse, pinch, and cleave fluids on demand, enabling cargo carriers with droplet wheels and upgrading the limit of maximum concentration of deliverable protein by 4000-fold." Professor Wang said.

The team will seek to integrate the platform with artificial intelligence (AI) system to work out a fully automatic system for liquid processing. In future, gene editing can be done with the click of a button, instead of repeated pipetting.

More information: Wei Li et al. Photopyroelectric microfluidics,

Science Advances (2020). DOI: 10.1126/sciadv.abc1693