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Hacking Office Printer for Multipurpose Droplet Production

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In recent years, numerous innovative methods have been developed to meet the increasing demand for high throughput production of monodisperse droplets.[1] These methods can be either passive, such as dripping[2], or active, such as acoustophoretic printing[3]. However, both often require elaborate fine-tuning or cost-heavy equipment, which inhibits the field's growth as it poses an entrance barrier for new researchers.

As a cheap and simple alternative to these methods, we have explored the use of commercial inkjet printers for the production of picoliter droplets; thereby, benefitting from decades of optimization in their speed, precision, and miniaturization. Nowadays, a 300\$ office printer can produce >10k droplets per second from nozzles spaced 80 μm apart and a size down to 1.5 picoliter. In addition, many modern inkjet printers allow for variation of the droplet size, which makes their versatility even more pronounced. Despite the clear advantages, challenges related to backlash induced printing repeatability and printer-roller introduced sample contamination have limited the exploration of the many possibilities.

Through simple hardware adjustments to the office printer, we have made it possible to print multiple times without smearing and improved the between-print positioning repeatability from millimeter range to below 50 μm . This improvement enables a manifold of new utilities for the inkjet system. The low-cost inkjet printer has six ink lines; thereby, immediately allowing for droplet production with six different liquids. We demonstrate simultaneous printing with both polar and non-polar liquids containing fluorescent dyes, drugs, bacteria, and colloids. In particular, we have focused on using the inkjet printer to load drugs into microcontainers for targeted delivery and personalized treatment. This new loading method is superior to its predecessor due to its possibility of easily customizable drug content.

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