Karlsruhe Institute of Technology

IBCS-FMS
Functional-Molecular-Systems

Automated Nanoliter Droplet Selection and Collection Device for Micro Droplet Arrays

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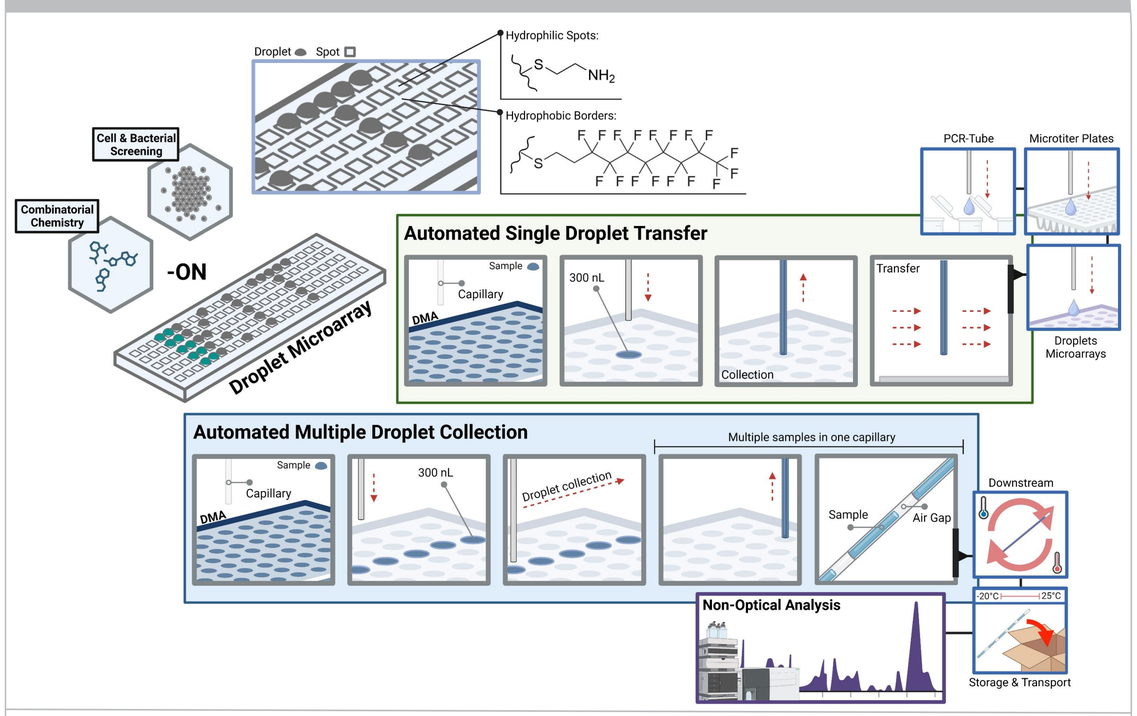
Overview



1. The Droplet microarray platforms enable high-throughput screening and analysis of small samples. However, handling nanoliter volumes is challenging.

2. We developed ANDeSCoDe, an automated approach that utilizes a removable fused silica capillary for the manipulation of multiple nanodroplets on droplet microarray platform.

3. The system provides a user-friendly approach for the selective collection and relocation of nanodroplets, aiming to tackle the challenge of Chip to World interface.

Introduction

1. ANDeSCoDe is a computer numerical control (CNC) device that employs three axes to precisely position a removable fused silica capillary connected to a syringe pump within the operating range.

2. The capillary connected to the syringe pump facilitates the re-collection and repositioning of the nanodroplets, allowing both **individual** and **bulk** collection.

3. After collection in the capillary, the nanodroplets can be subjected to further processing, such as incubation or thermal cycling, without requiring transfer to another vessel. The capillary also enables long-term storage of nanodroplets at low temperatures and facilitates transportation to other equipment for downstream analysis.

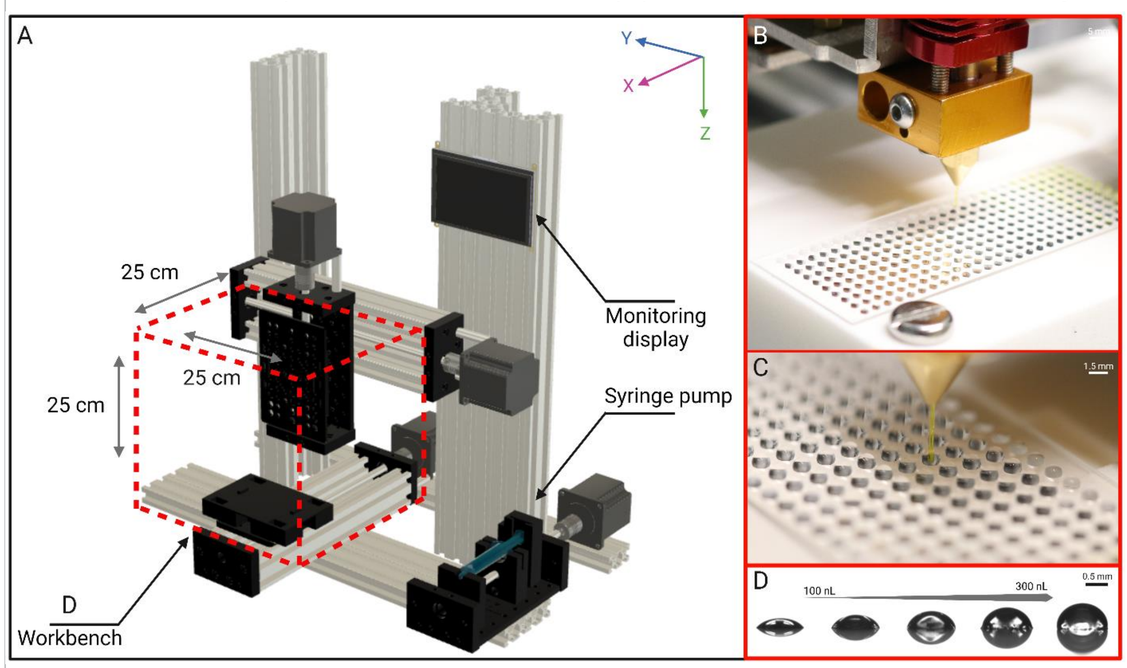
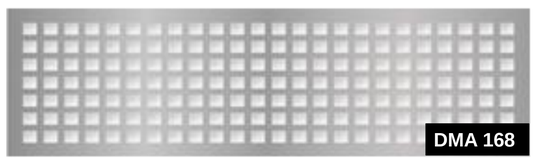


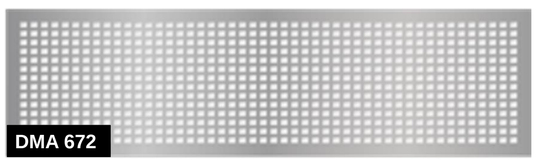
Figure 1: *3D rendering illustrating the main features of the Automatic Nanoliter droplet selection and collection device (ANDeSCoDe). (**A**) 3D renderings of the ANDeSCoDe based on a CAD model. The red box represents the work station. (**B**) Image of the workbench, showing the capillary holder nozzle, and a Droplet Microarray. (**C**) Droplet Microarray of 320 spots. Each spot has a diameter of 1.4 mm and contains 1 µL of water, with a distance of 2.2 mm between them. (**D**) Different volumes of water printed on 1 mm² hydrophilic spots, surrounded by hydrophobic borders.*

Results

	X (mm)	Y (mm)	Z (mm)
Accuracy	± 0.0254	± 0.0508	± 0.0254
Repeatability	± 0.1524	± 0.1778	± 0.1270

Hydrophilic spots: 7 x 24 = 168
Spot dimensions: 2000 µm x 2000 µm
Distance between spots: 1000 µm
Distance between spot centers: 3000 µm





Hydrophilic spots: 14 x 48 = 672
Spot dimensions: 1000 µm x 1000 µm
Distance between spots: 500 µm
Distance between spot centers: 1500 µm

Hydrophilic spots: 18 x 64 = 1152
Spot dimensions: 900 µm x 900 µm
Distance between spots: 225 µm
Distance between spot centers: 1125 µm

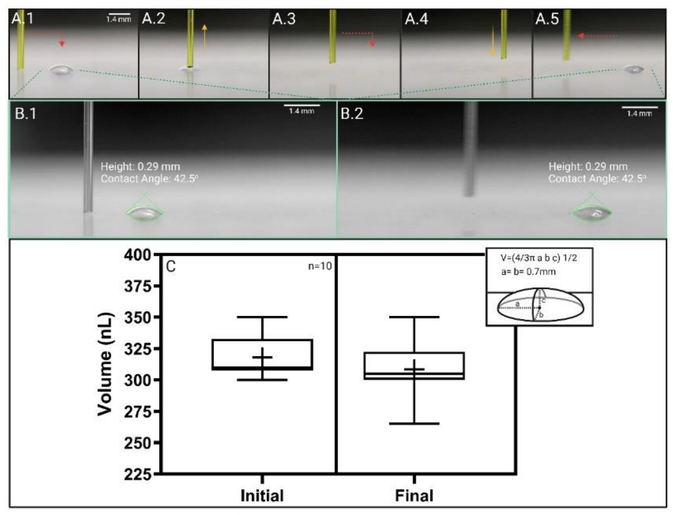


Figure 2: Assessment of droplet transfer efficiency. (**A: 1,2,3,4,5**) Step-by-step demonstration of the automatic collection and relocation of a 300 nL droplet. (**B.1**) Analysis of droplet height and angle prior to collection. (**B.2**) Analysis of droplet height and angle after relocation. (**C**) Comparison of the final and initial volumes of the analyzed droplets (n=10).

Average volume lost: 2.98%

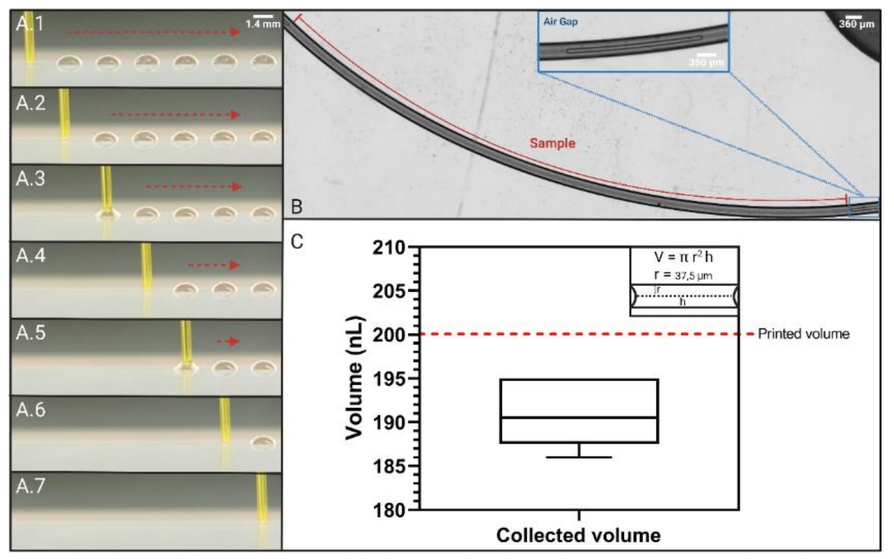
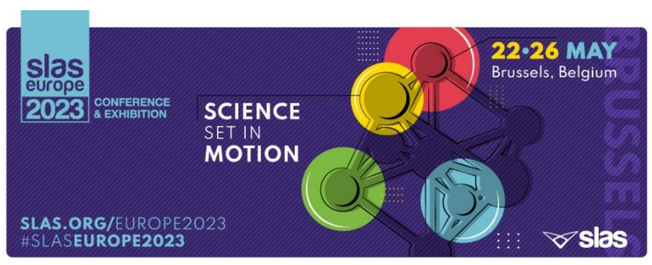


Figure 3: *Evaluation of automatic multi-drop collection. (**A: 1,2,3,4,5,6,7**) Reference image of the step-by-step sequence of an automatic collection of 6 drops printed on a 1.4 mm Ø DMA. (**B**) Image of a sample collected in the fused silica capillary. The image shows what a sample looks like inside the capillary as well as the air gaps between samples. (**C**) Comparison between the printed volume (200 nl) and the volume automatically collected by capillary.*

Average volume lost: 4.6%

Conclusion

ANDeSCoDe is a versatile and customizable solution that offers great potential for a variety of On-chip applications, such as drug screening, omics analysis, combinatorial chemistry, and others. The device is capable of handling nanodroplets in a precise and automated manner, thus providing an efficient means of platform control, while minimizing the possibility of human error and reducing the arduous task of manual droplet collection. Its adaptability to different microarray platforms make it a promising tool for a wide range of laboratory applications.



SCAN ME!

Acknowledgements

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