3D-μNMADs

3D Nanofiber-based Microfluidic Analytical Devices

<Literature Review>

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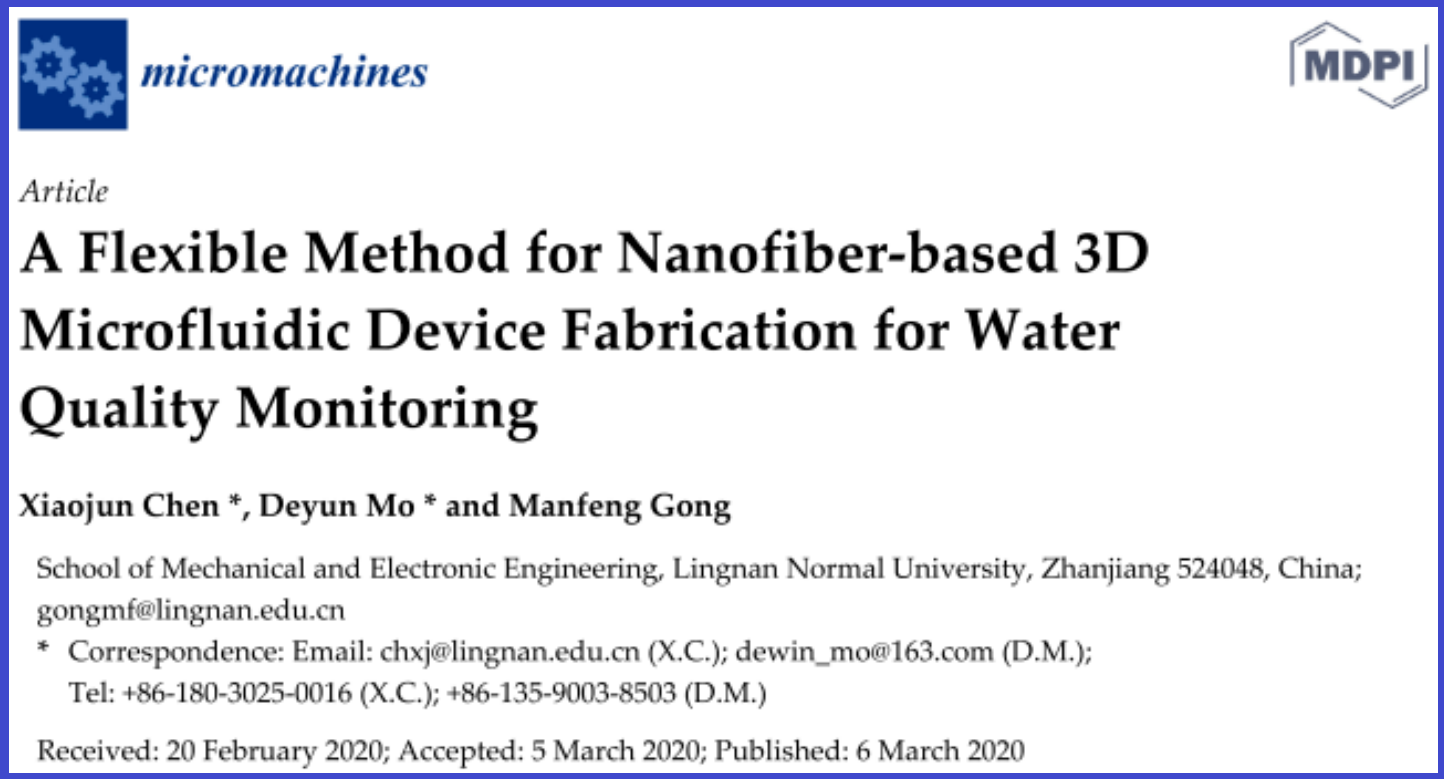
28 Oct 2020



micromachines

MDPI

Article

A Flexible Method for Nanofiber-based 3D Microfluidic Device Fabrication for Water Quality Monitoring

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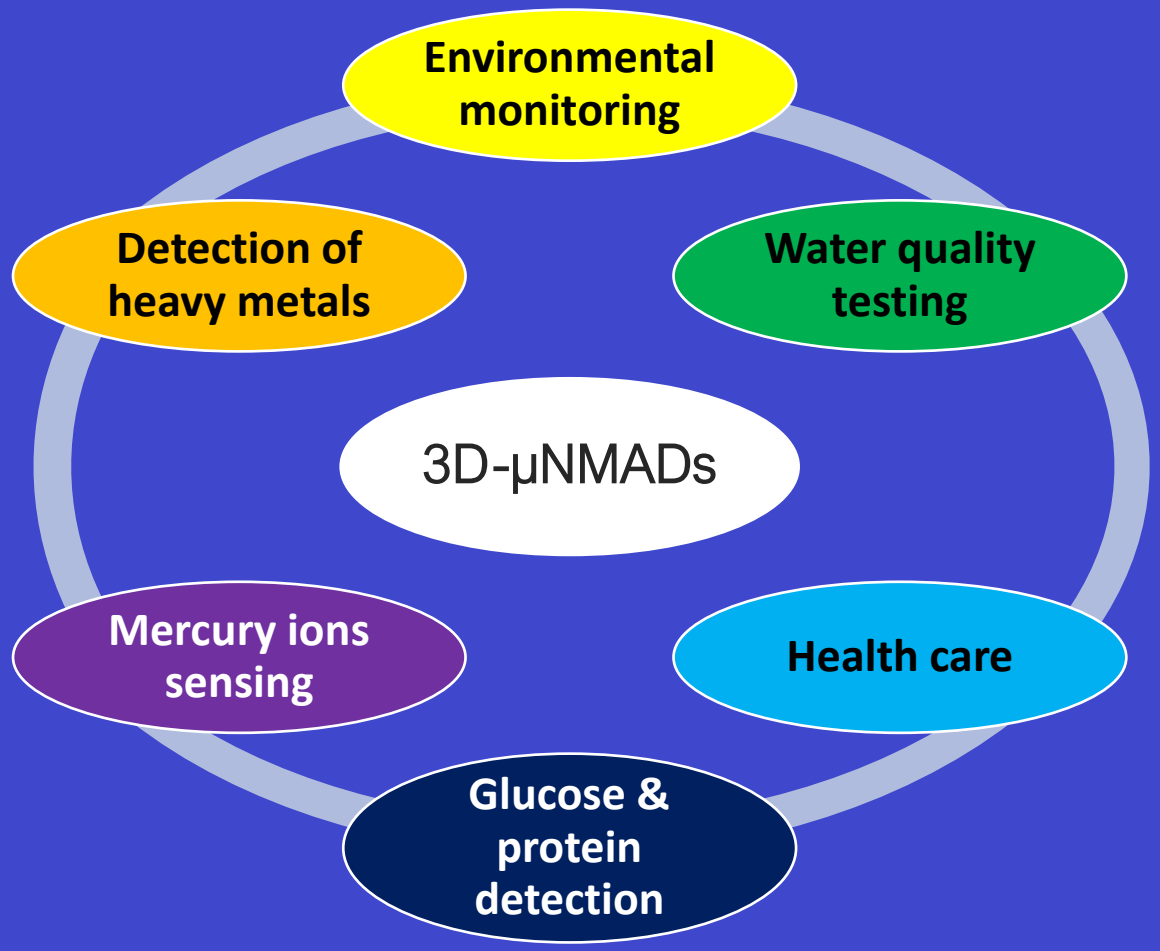
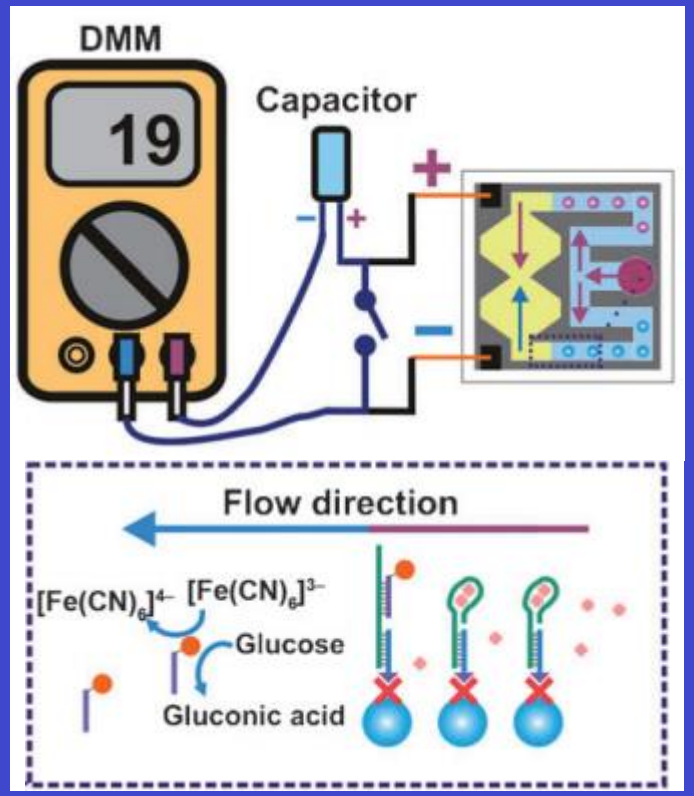
nanofibers + microfluidic chips + sensors + electrospinning

X. Chen, D. Mo, M. Gong, A Flexible Method for Nanofiber-based 3D Microfluidic Device Fabrication for Water Quality Monitoring, Micromachines. 11 (2020) 276. https://doi.org/10.3390/mi11030276.

Applications:



e.g. by Liu et al.



Liu, H., Xiang, Y., Lu, Y., & Crooks, R. M. (2012). Aptamer-Based Origami Paper Analytical Device for Electrochemical Detection of Adenosine. Angewandte Chemie International Edition, 51(28), 6925–6928. doi:10.1002/anie.201202929

Fabrication techniques (state-of-the-art):

2D structures
- photolithography
- spray printing
- paper cutting
- inkjet printing
- screen printing

3D structures
- 2D stacking
- paper origami

Well know techniques, Simple & Easy to implement

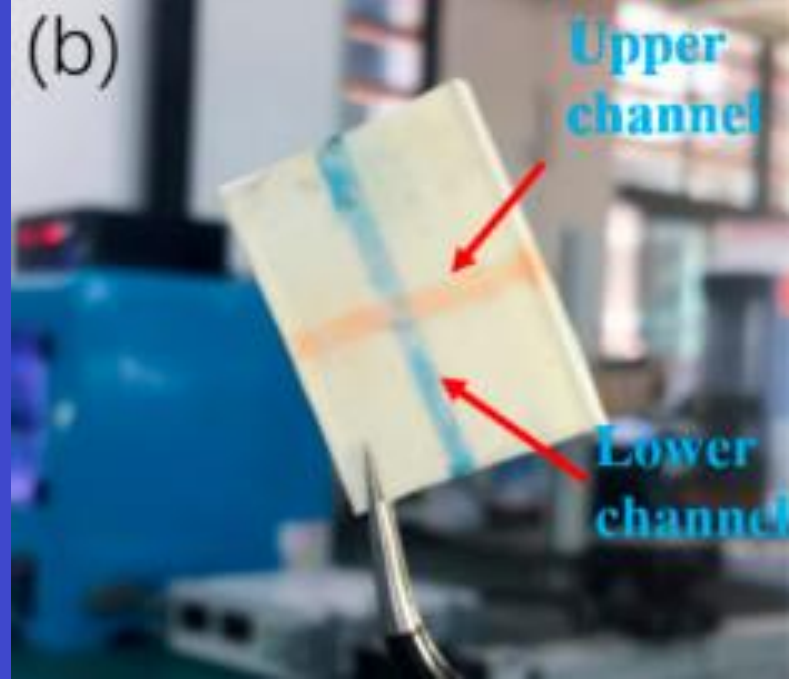
vs.

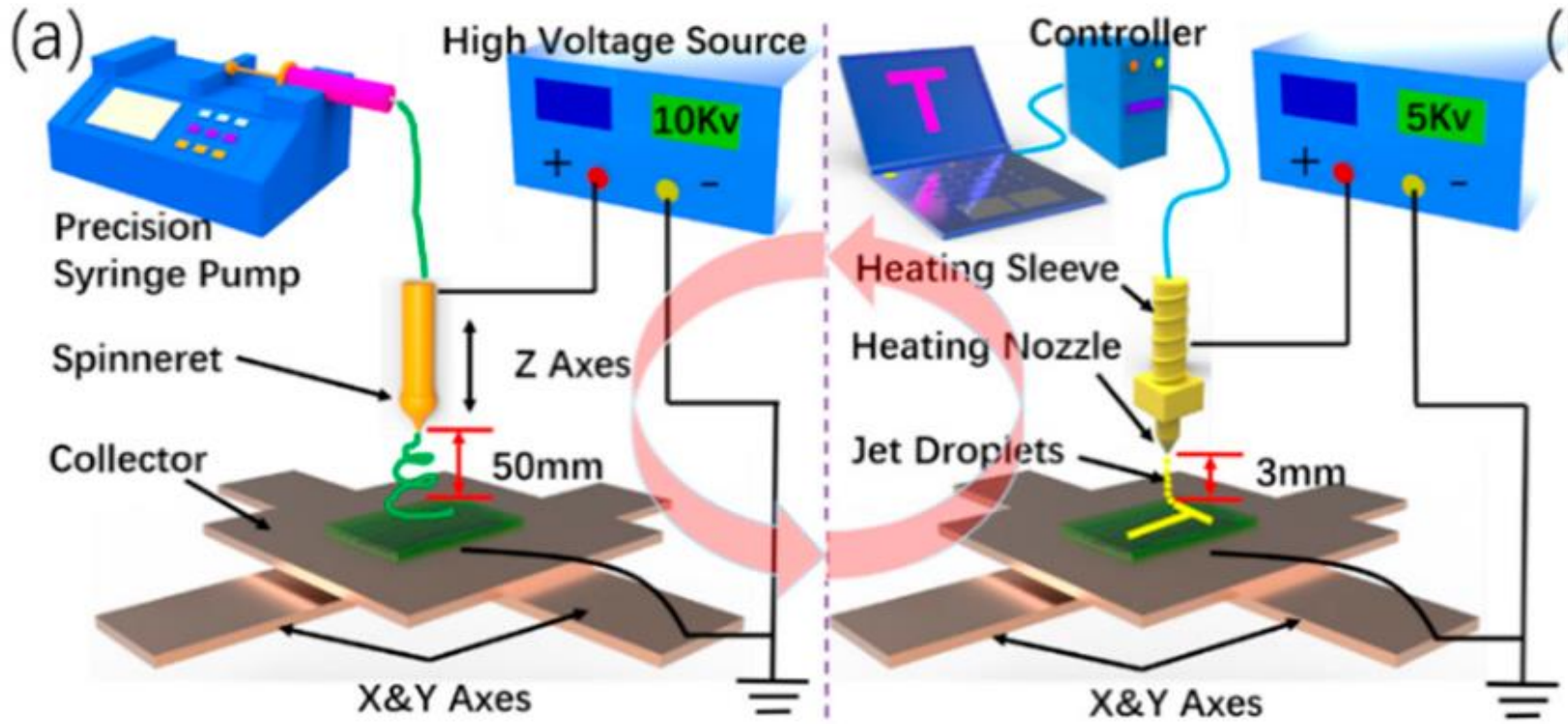
Increased functionality & Fewer geometry limitations

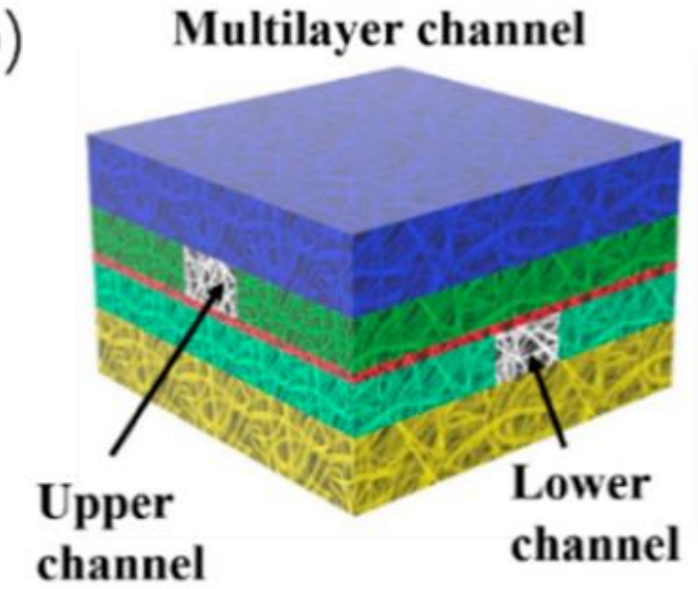
Materials and Methods:

FFES ink: polyimide (PI) and silicon powder (Si) in dimethylacetamide (DMAc)

melt-NFES: wax

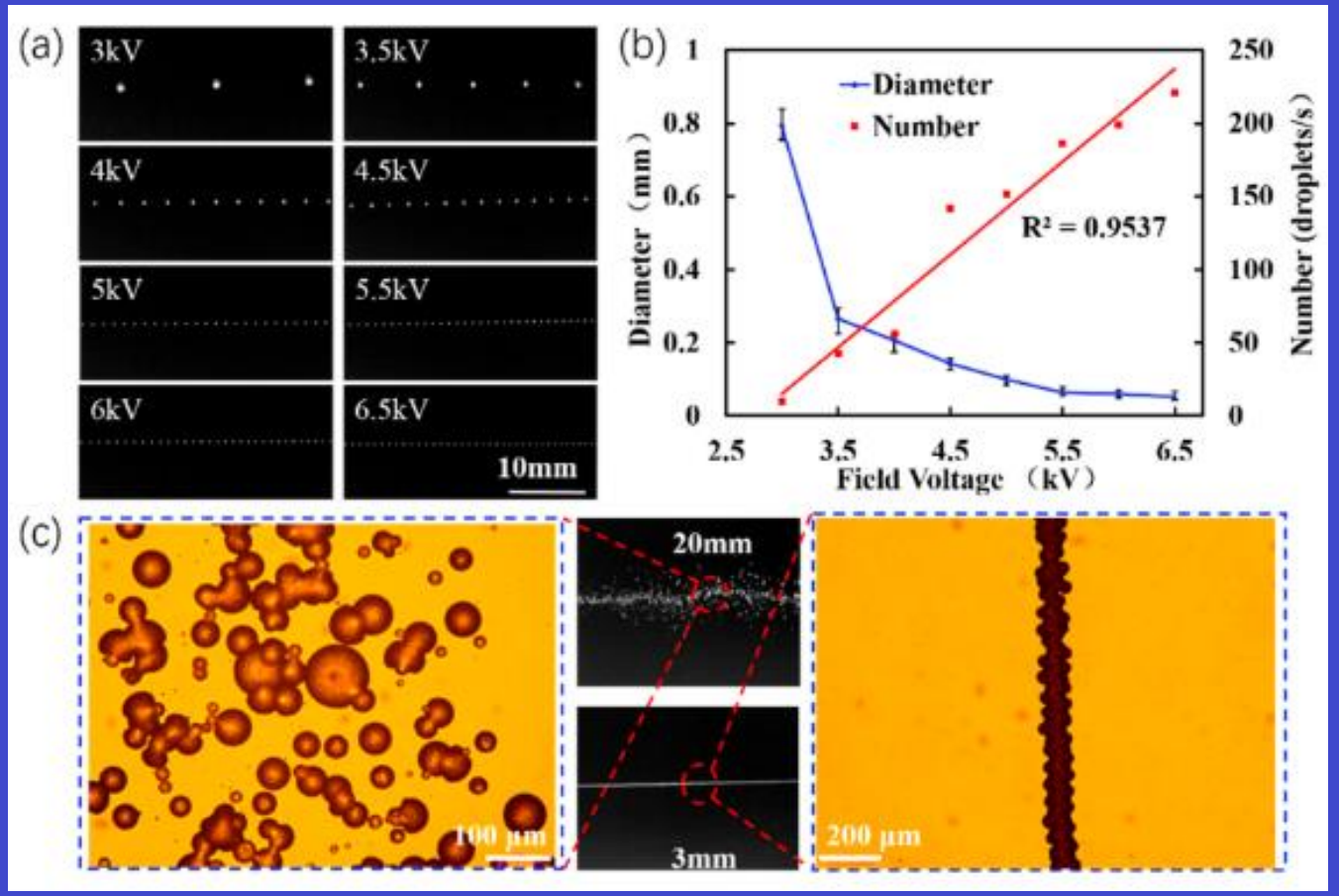




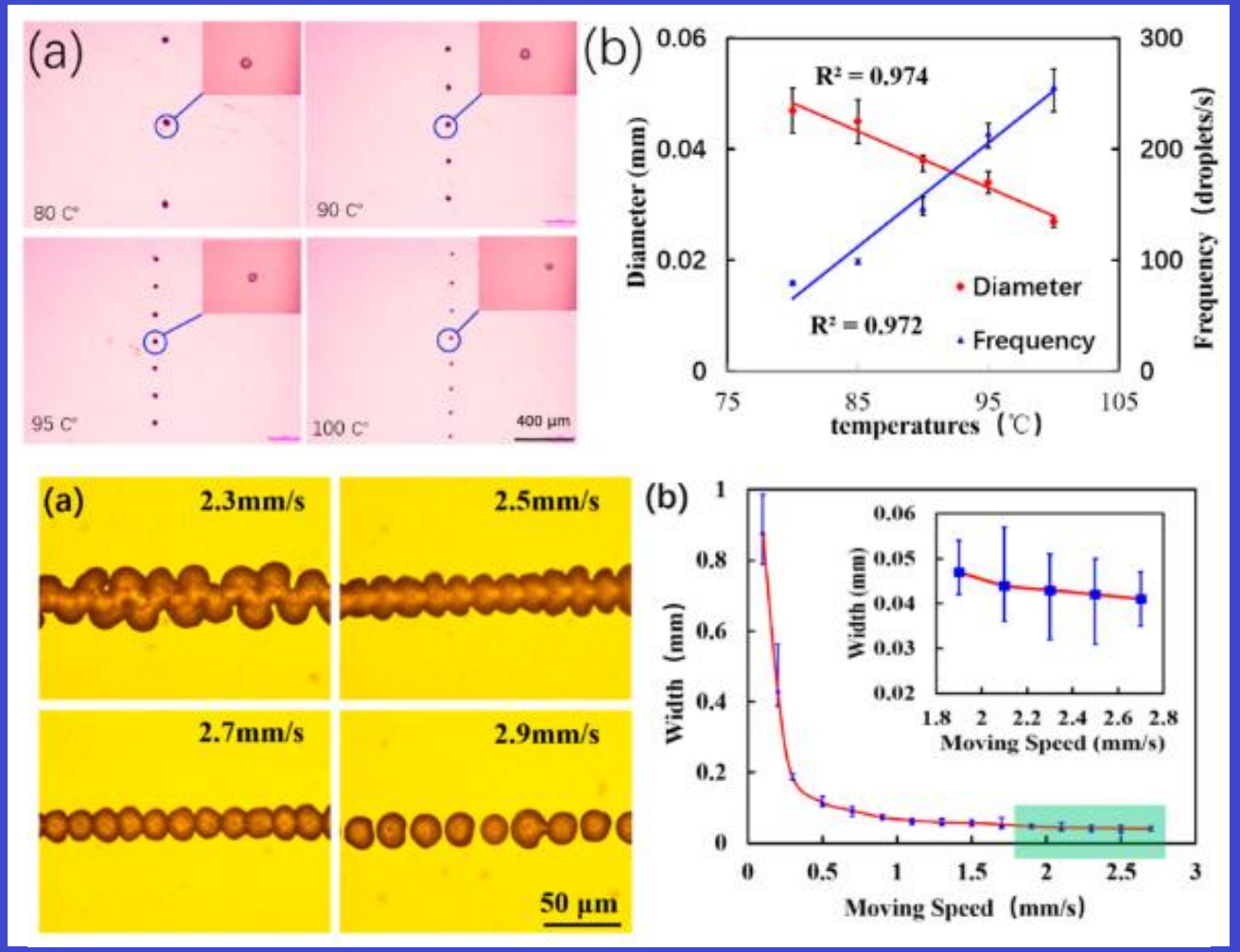


Process parameters (applied voltage & working distance):

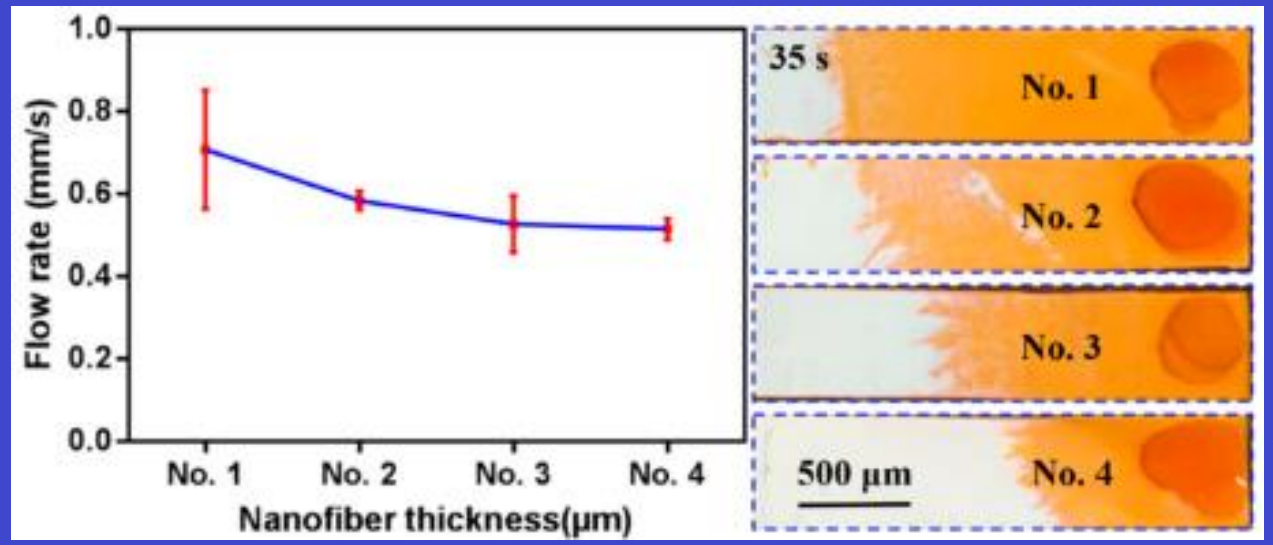
"NFES wax printing is an atomization process rather than a spinning process."



Process parameters (temperature & stage velocity):



Performance of 3D-μNMADs:



"Faster flow rates were observed in thin membranes."

Membrane porosity decreased and became denser after a long deposition time (No. 4), which resulted in a reduced flow.

Conclusions:

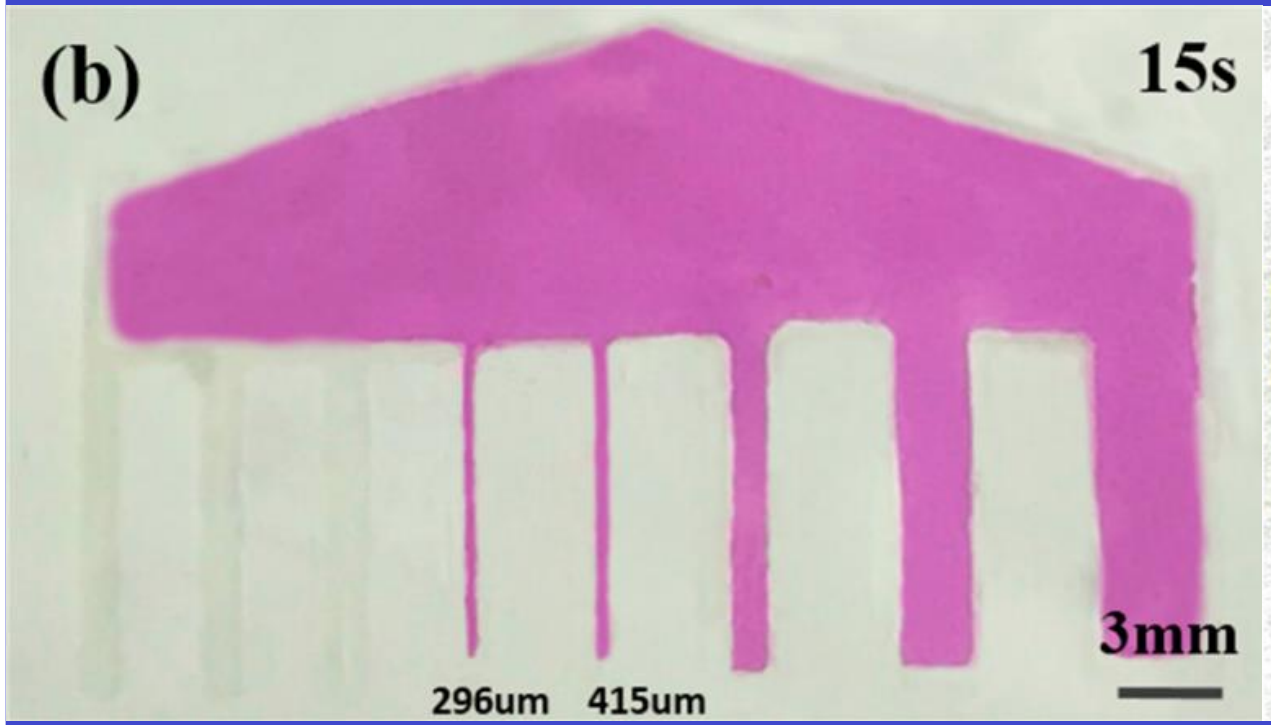
Wax spreading can be controlled by the alignment of the electrospun nanofibers

Nanofiber-based (this paper)

Inkjet printing (Carrilho et al.)

Carrilho, E., Martinez, A. W., & Whitesides, G. M. (2009). Understanding Wax Printing: A Simple Micropatterning Process for Paper-Based Microfluidics. Analytical Chemistry, 81(16), 7091–7095. doi:10.1021/ac901071p

Conclusions (resolution):



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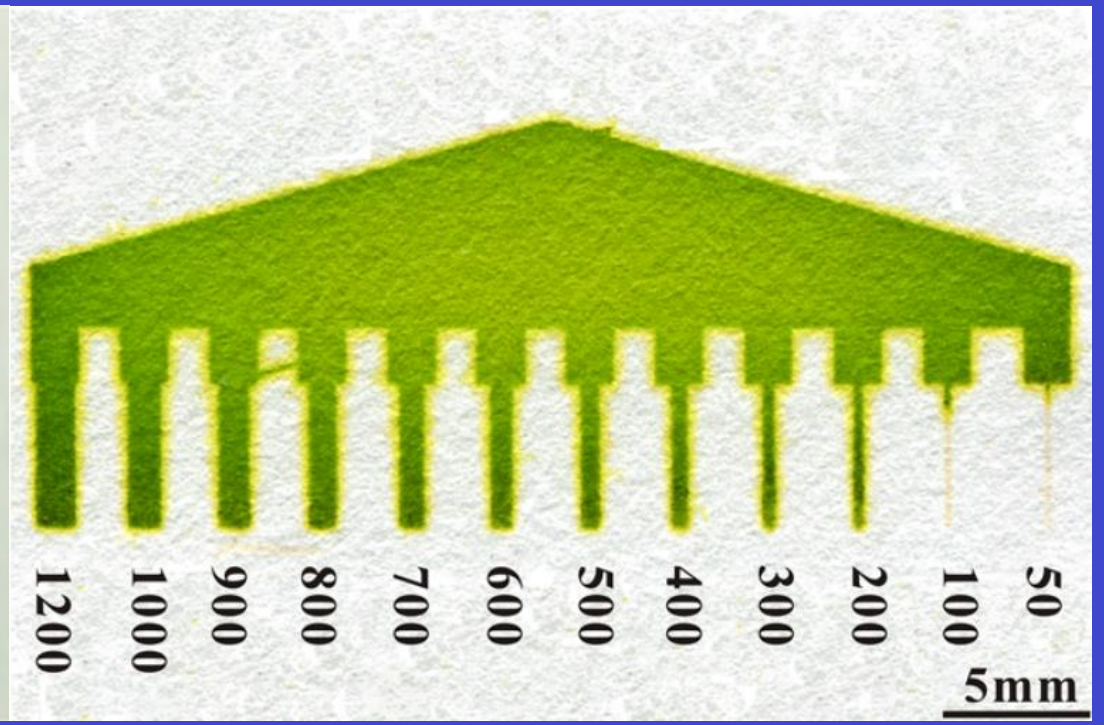

Photolithography (He et al.)

Dungchai, W., Chailapakul, O., & Henry, C. S. (2011). A low-cost, simple, and rapid fabrication method for paper-based microfluidics using wax screen-printing. The Analyst, 136(1), 77–82. doi:10.1039/c0an00406e
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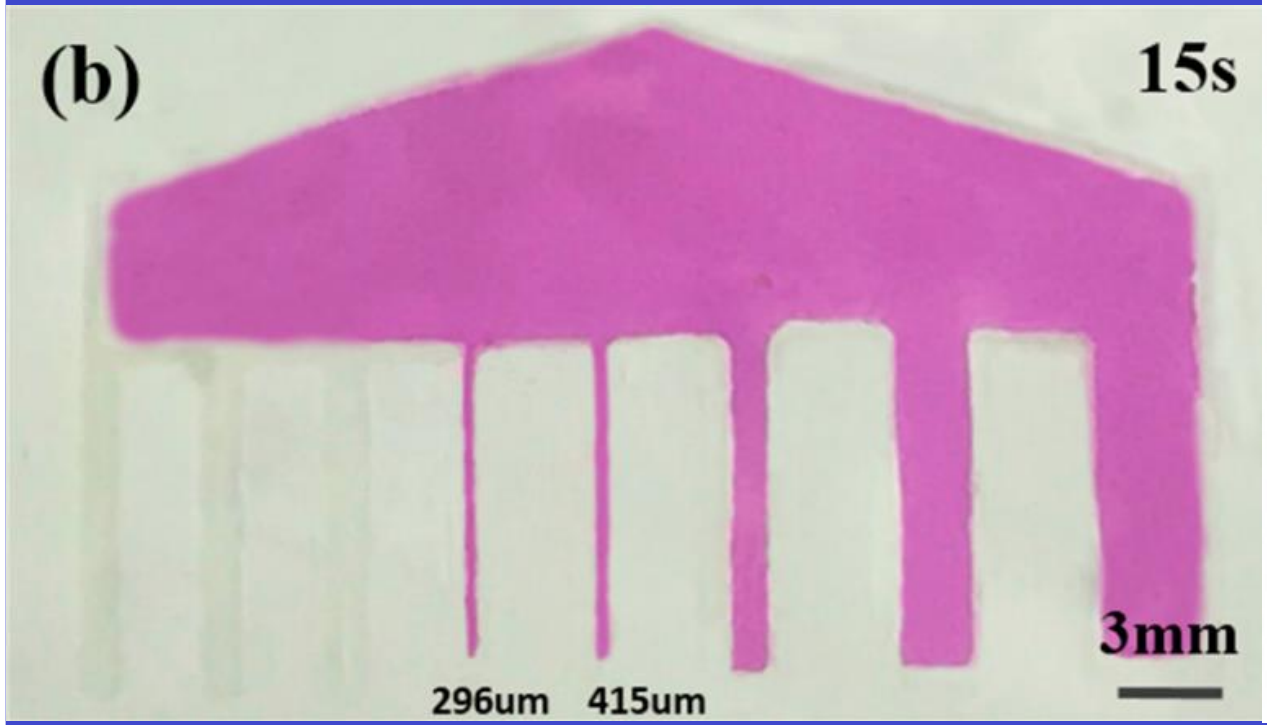

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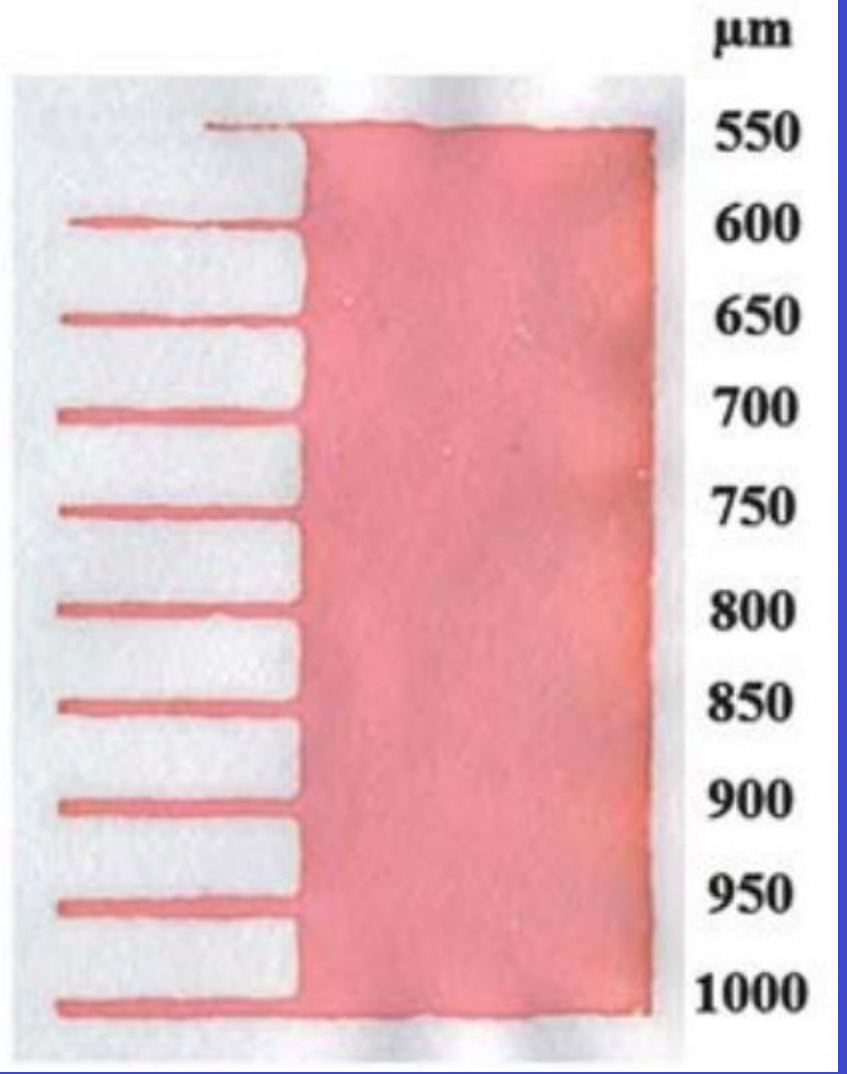

Screen printing (Dungchai et al.)

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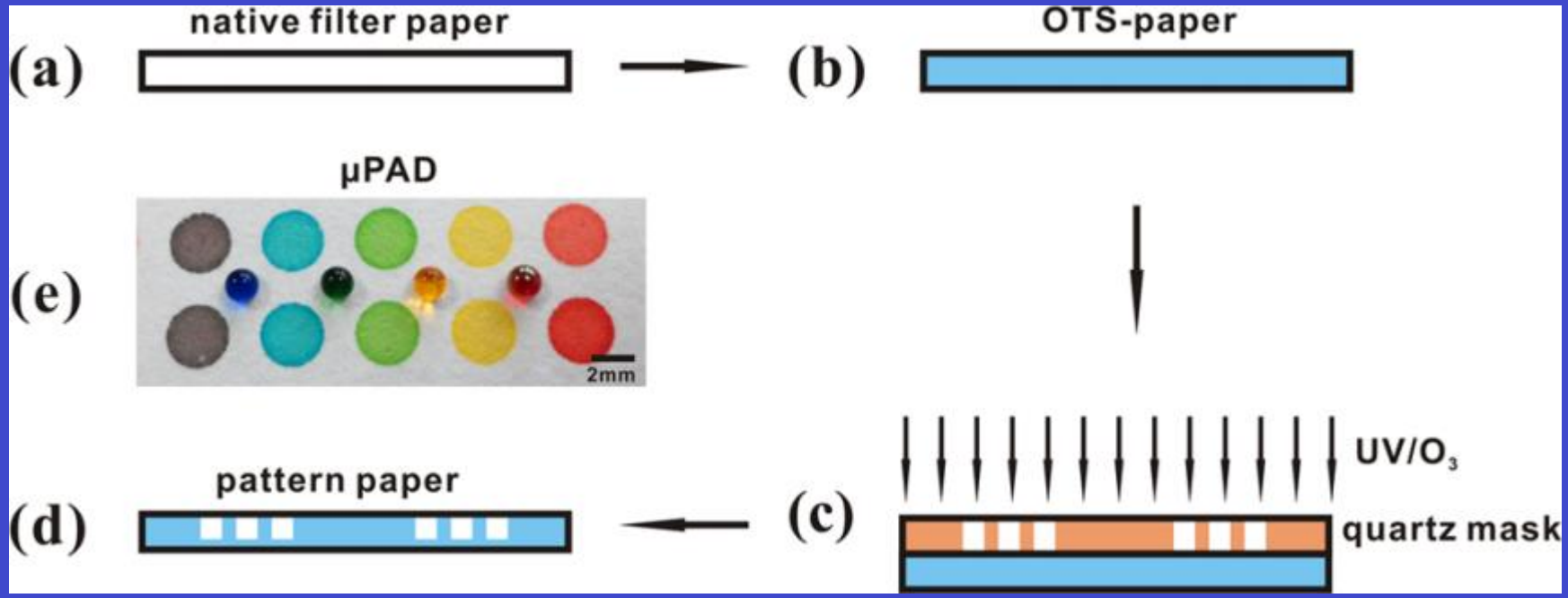
Q&A

Photolithography



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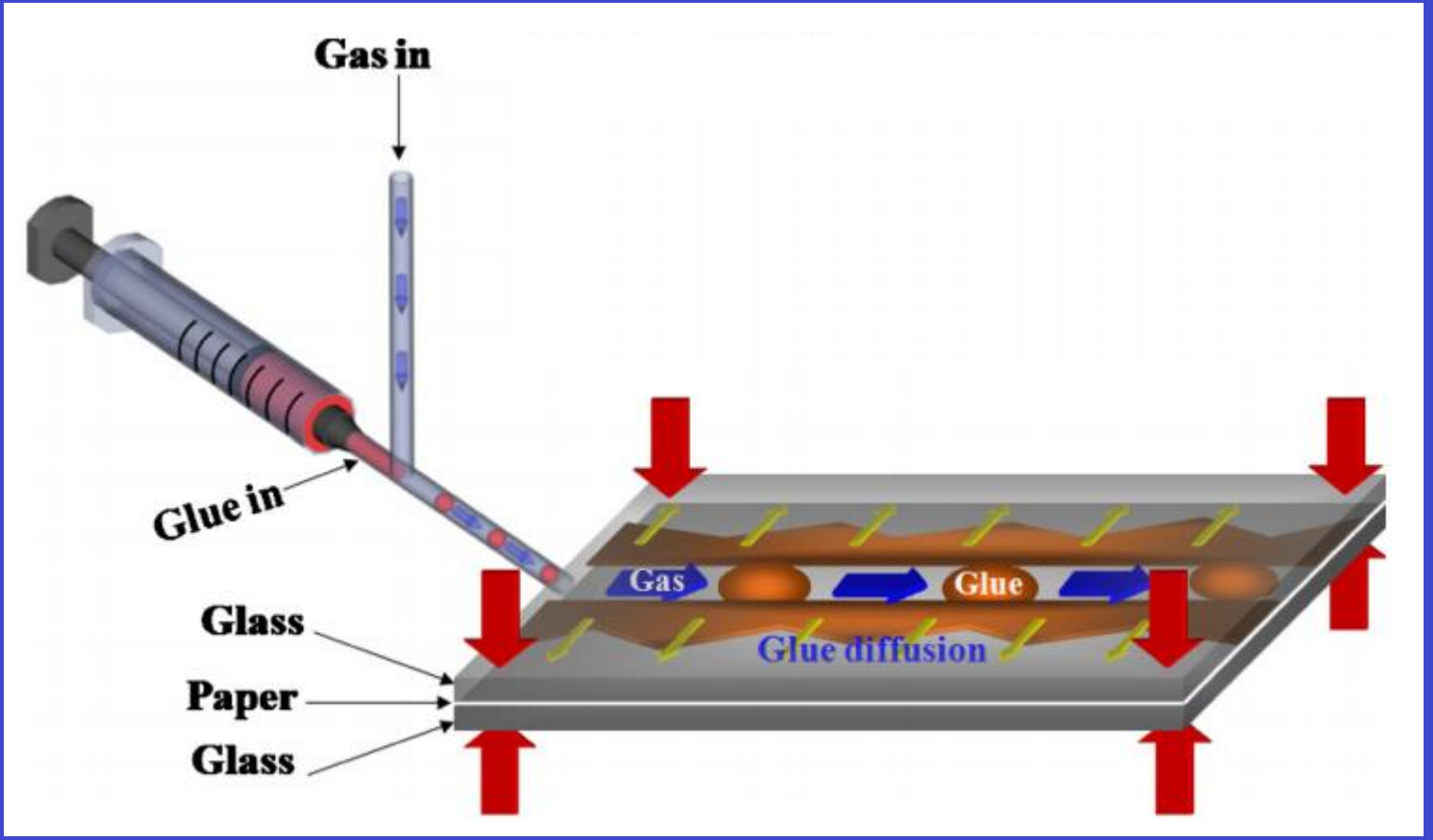
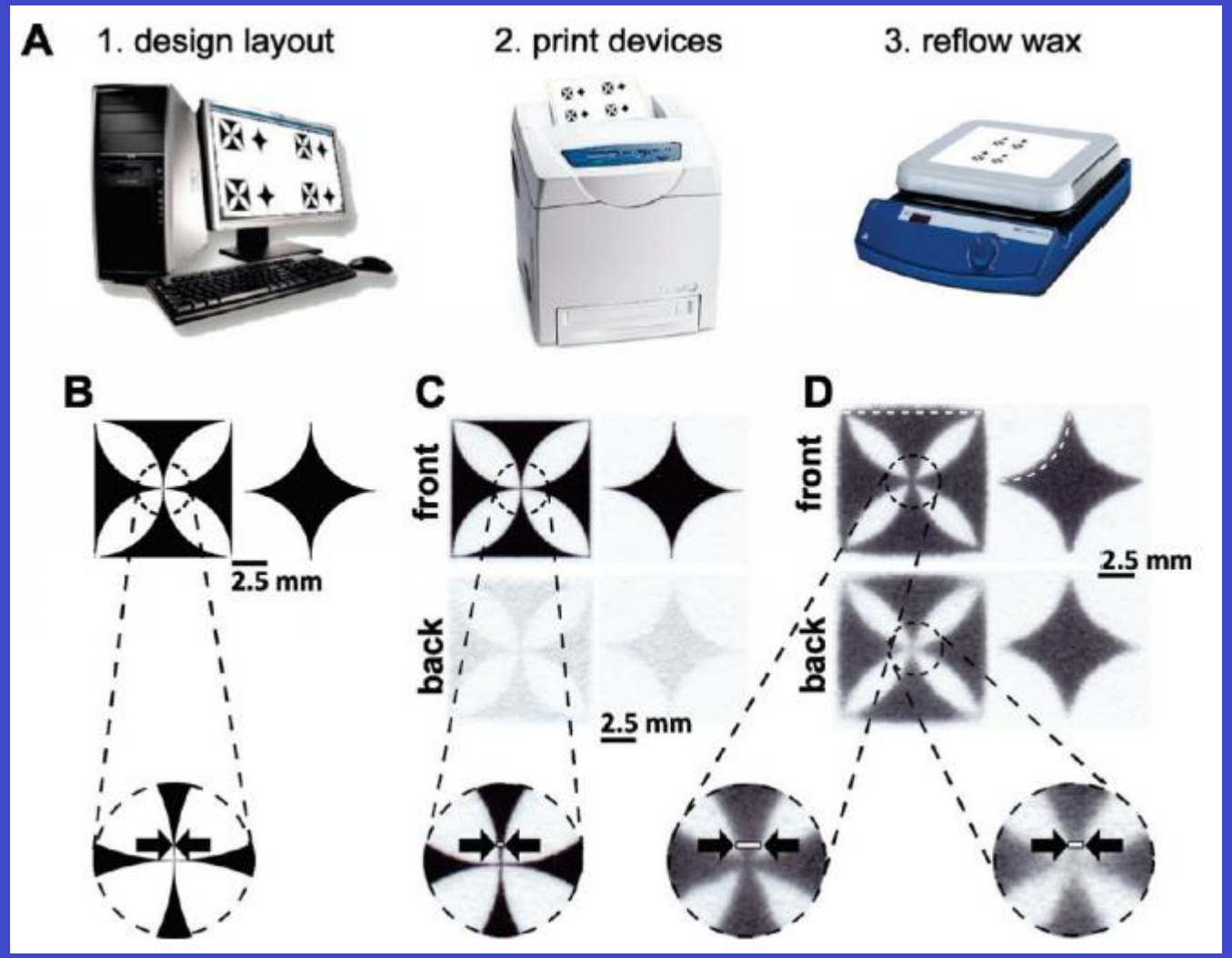
Paper cutting



Yi, X., Kodzius, R., Gong, X., Xiao, K., & Wen, W. (2010). A simple method of fabricating mask-free microfluidic devices for biological analysis. Biomicrofluidics, 4(3), 036503. doi:10.1063/1.3487796

inkjet printing



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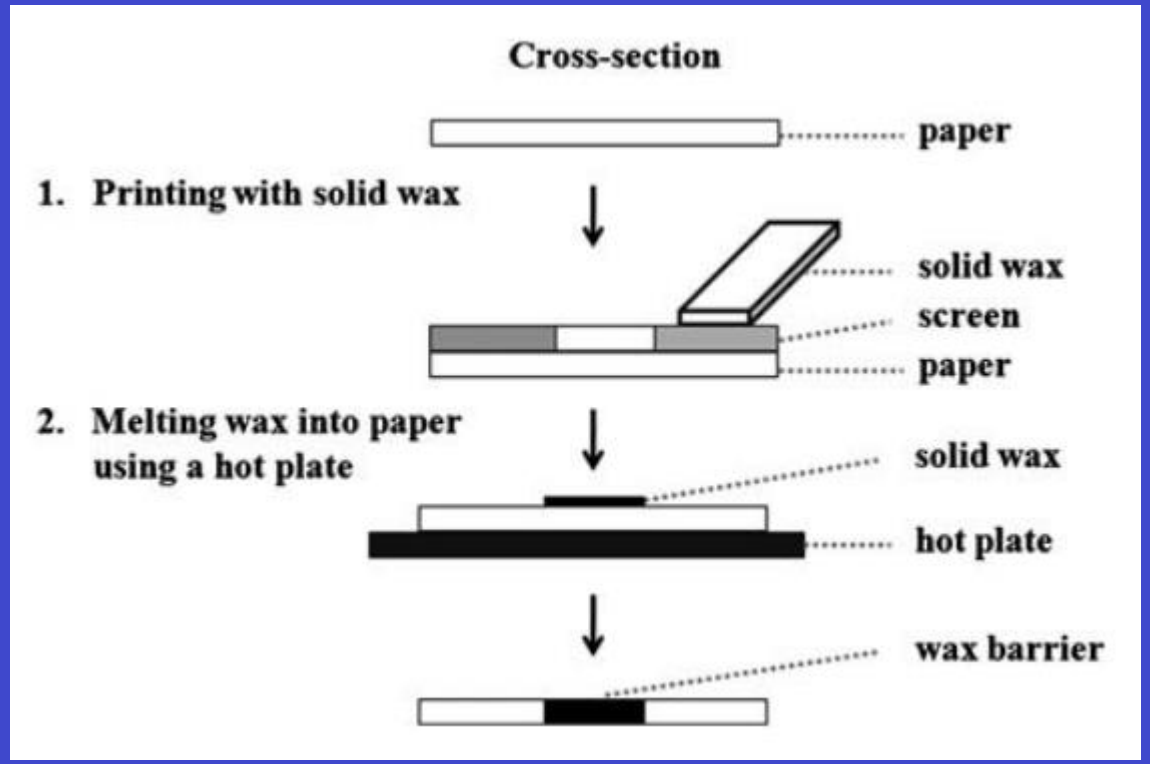
Screen printing



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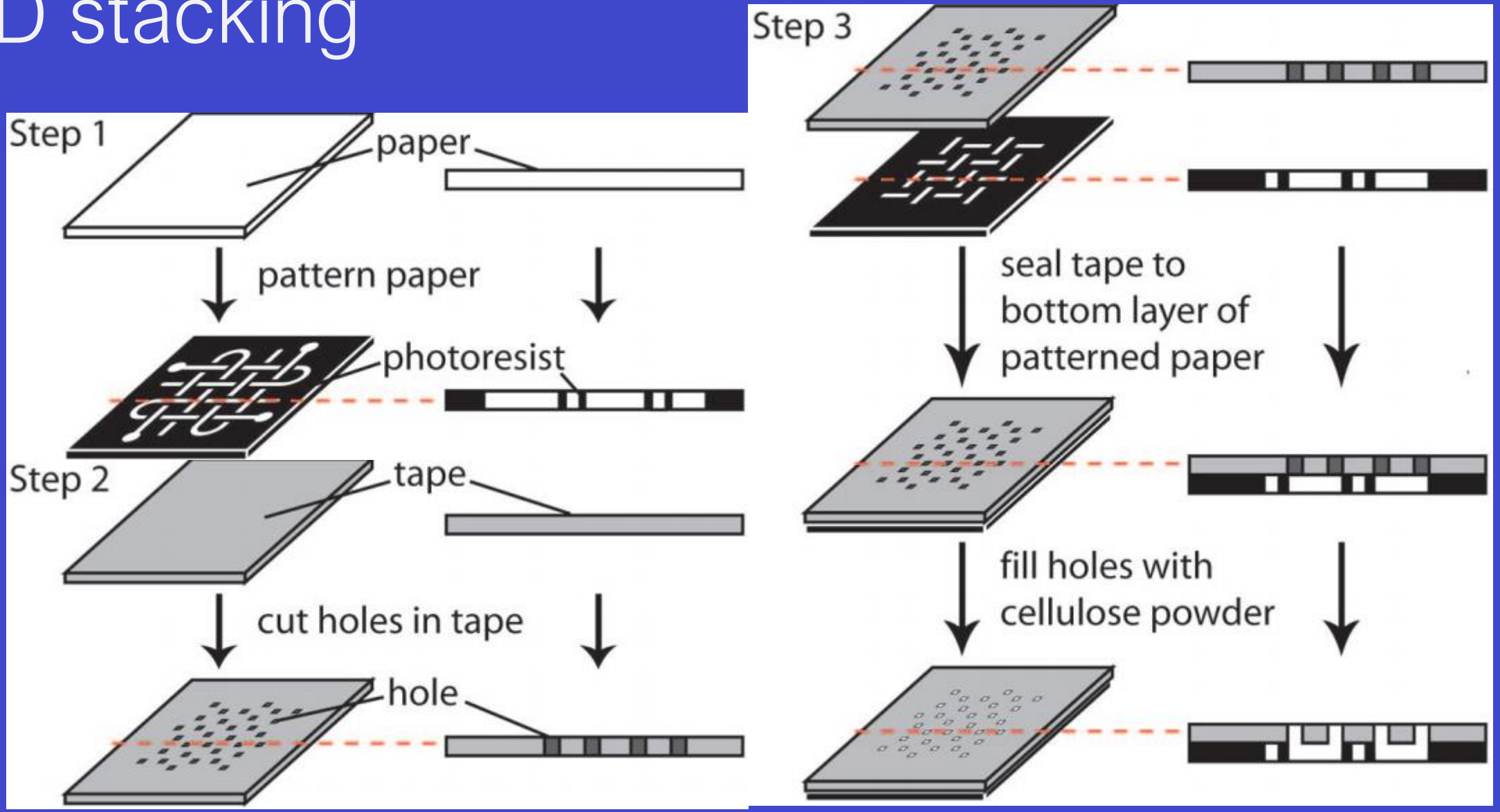
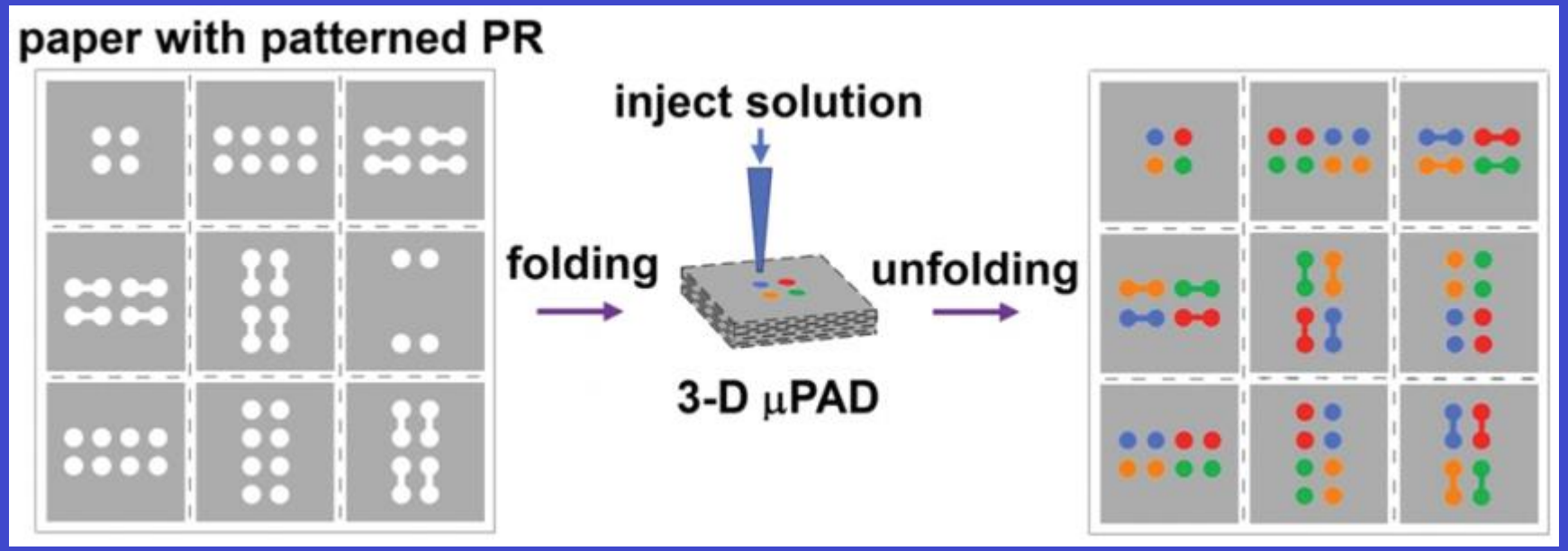
2D stacking



Martinez, A. W., Phillips, S. T., & Whitesides, G. M. (2008). Three-dimensional microfluidic devices fabricated in layered paper and tape. Proceedings of the National Academy of Sciences, 105(50), 19606–19611. doi:10.1073/pnas.0810903105

Paper origami



Liu, H., & Crooks, R. M. (2011). Three-Dimensional Paper Microfluidic Devices Assembled Using the Principles of Origami. Journal of the American Chemical Society, 133(44), 17564–17566. doi:10.1021/ja2071779