Fabrication of complex-shaped colloids via selective microfluidic trapping

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Introduction

- Direct laser writing (DLW) via two-photon polymerization (2PP) enables fabrication of complex 3D colloidal particles
- Conventional substrate-based fabrication limits yield and surface functionalization, resulting in heterogeneous anchoring after particle detachment

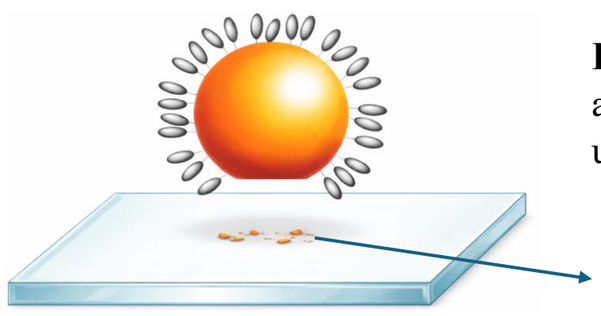

Figure 1: Heterogeneous anchoring causes non-uniform director alignment.

Aim

- Enable uniform surfactant access to all particle surfaces via free-floating DLW fabrication in a microfluidic channel
- Enable surface alignment of NLCs via printed nanogrooves
- Increase particle yield

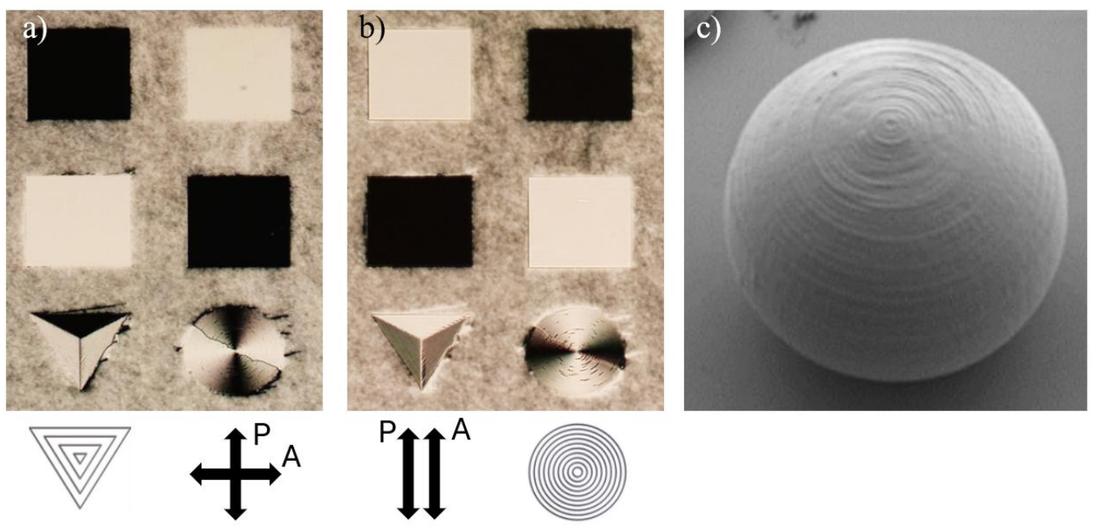

Figure 2: Alignment of NLC by printed nanogrooves: (a, b) 2D patterns under crossed and parallel polarizers, respectively; (c) 3D nanogroove-induced alignment.

Methodology

- Printing free floating particles inside microfluidic channels
- Developing and solvent exchange (flow direction)
- Adding surfactants
- Selectively trapping particles with a printed barrier
- Adding NLC from barrier side to extract particles

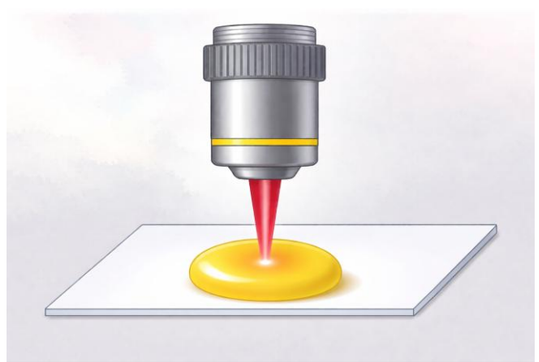

Figure 3: DLW via 2PP, enabling localized 3D fabrication within a photoresist.

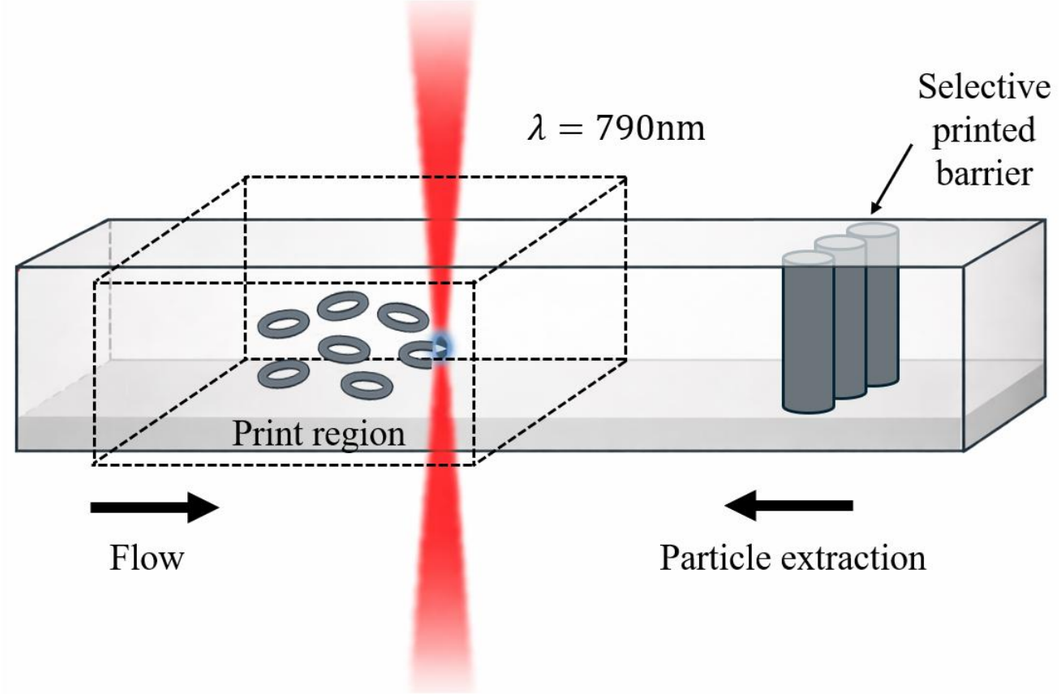

Figure 4: Schematic of microfluidic DLW setup. Particles are fabricated by 2PP inside a defined trapping region, enabling selective retention and extraction under flow.

Results

- Free-floating DLW fabrication demonstrated in microfluidic environment
- Successful trapping and retention of printed colloids under flow
- Higher particle yield than substrate-based printing
- Full surface exposure enables uniform post-functionalization

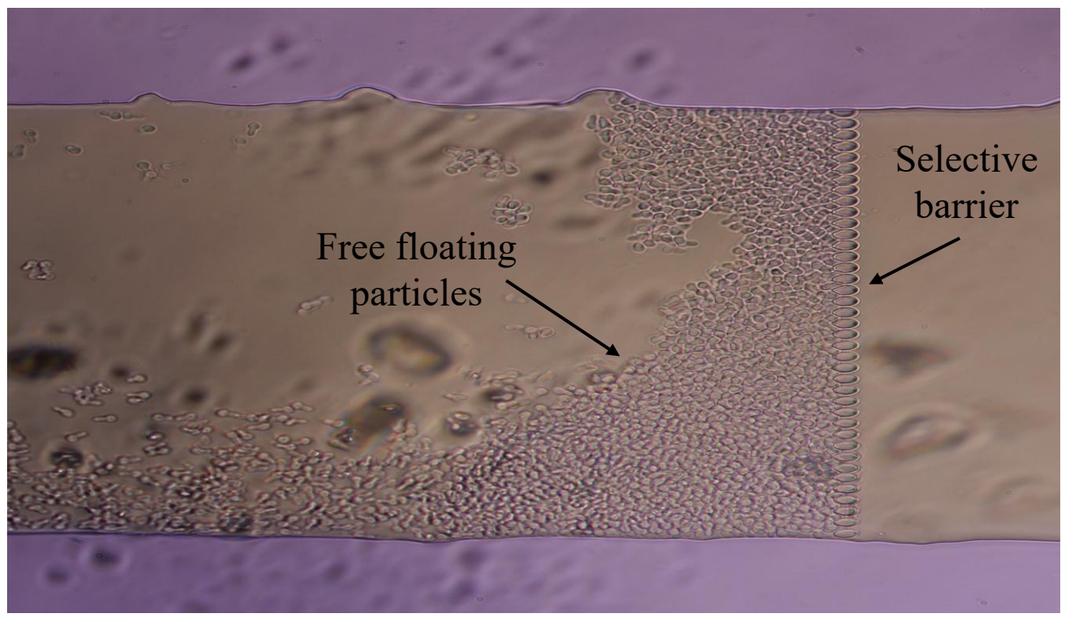

Figure 5: Optical micrograph of colloidal particles selectively trapped at the permeable boundary inside the microfluidic channel.

Conclusion

- Mechanical removal and sacrificial layers damage fragile acrylate colloids and reduce yield.
- Free-floating microfluidic DLW enables uniform anchoring and high-yield colloid fabrication.

References

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[3] U. Jagodič *et al.*, *Liq. Cryst.* **50**, 1999 (2023).