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# Fabrication of Large Arrays of Plasmonic Nanostructures *via* Double Casting

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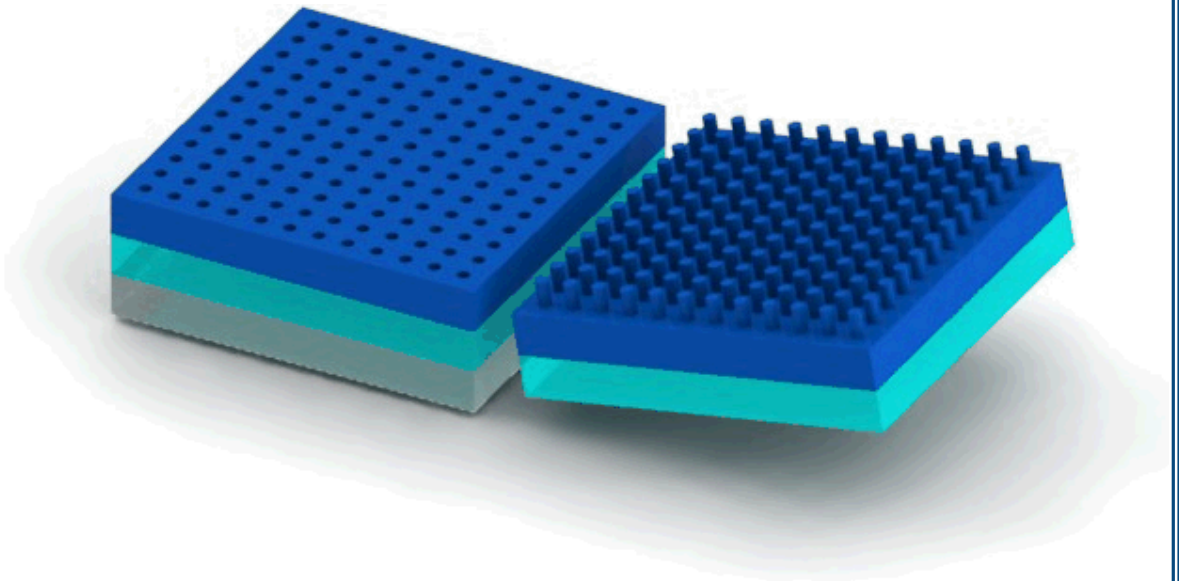
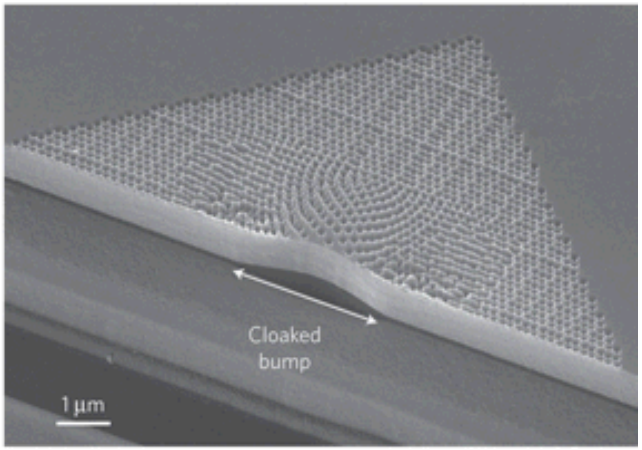
# Agenda

- Motivation
- Background
- Concept
  - Large Arrays of Nanostructures via Double Casting
- Fabrication
- Results
- Conclusions



# Motivation

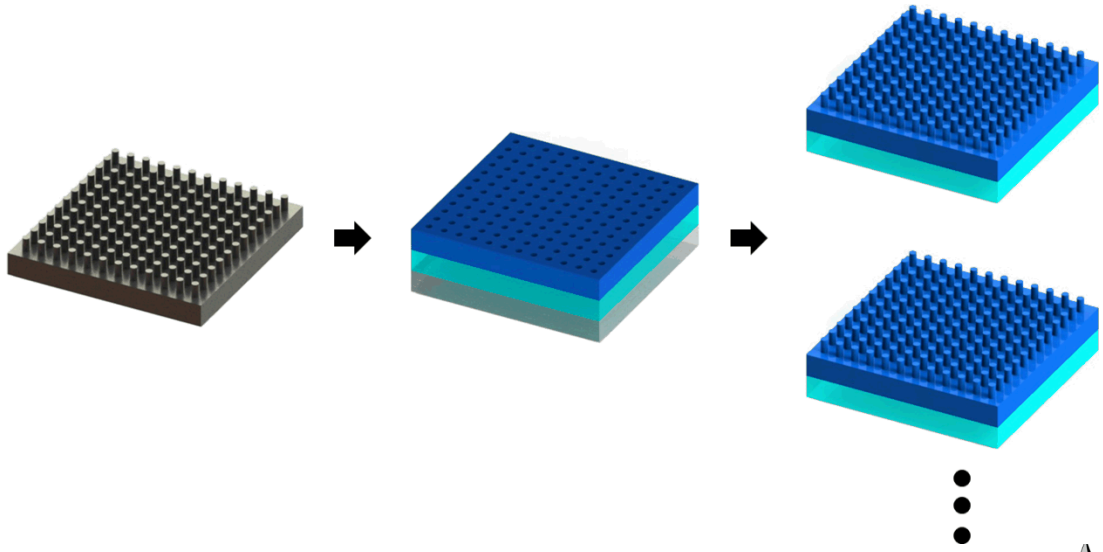
- **Plasmonic nanostructures for real-world applications**
  - Superlenses
  - Nanoantennas
  - Optical cloaking
- Large arrays of nanostructures are created using expensive and complicated procedures
- A cost-efficient fabrication method is needed




Jason Valentine, Jensen Li, Thomas Zentgraf, Guy Bartal & Xiang Zhang Nature Materials 8, 568 - 571 (2009)

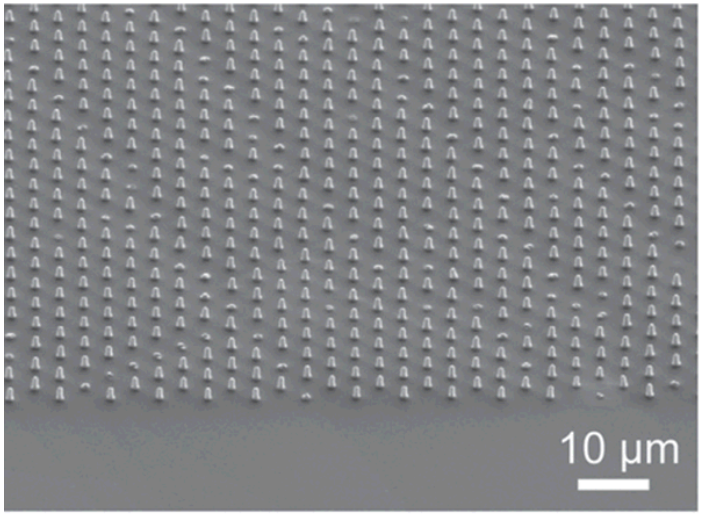
# Background

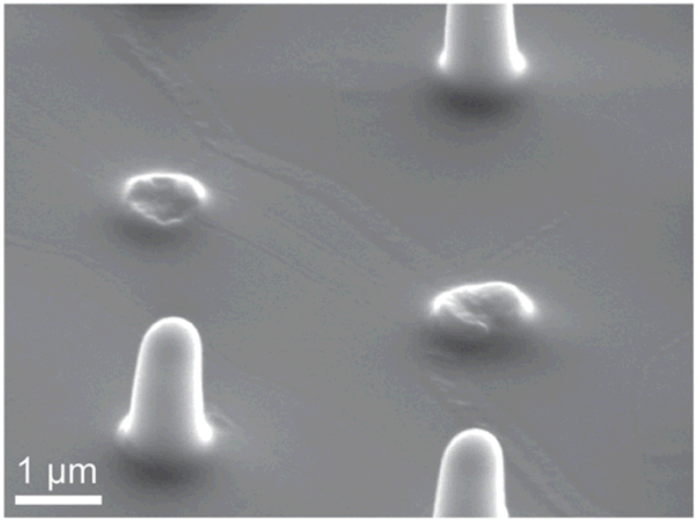
- Double Casting
  - Create multiple polymeric templates from one master template
  - Allow fabrication of positive and negative copies
  - PDMS is a common material for double casting



# Challenges

- Uncured PDMS adheres to untreated, cured PDMS
- Passivation procedure involves $O_2$ plasma
  - Causes thermal fractures in PDMS

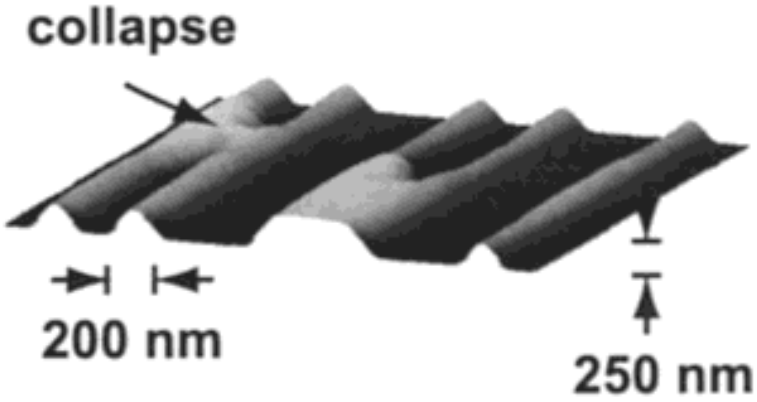


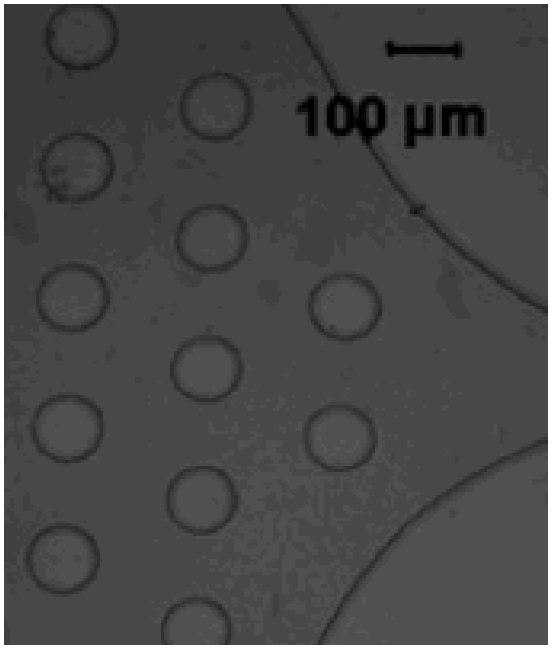

Tooley et al., Thermal fracture of oxidized polydimethylsiloxane during soft lithography of nanopost arrays. *J. Micromech. Microeng*, 2011. **21**: p. 054013.

# Challenges

- Sylgard 184 PDMS has high viscosity and low Young's modulus
  - Not suitable for fabrication of sub-500nm features



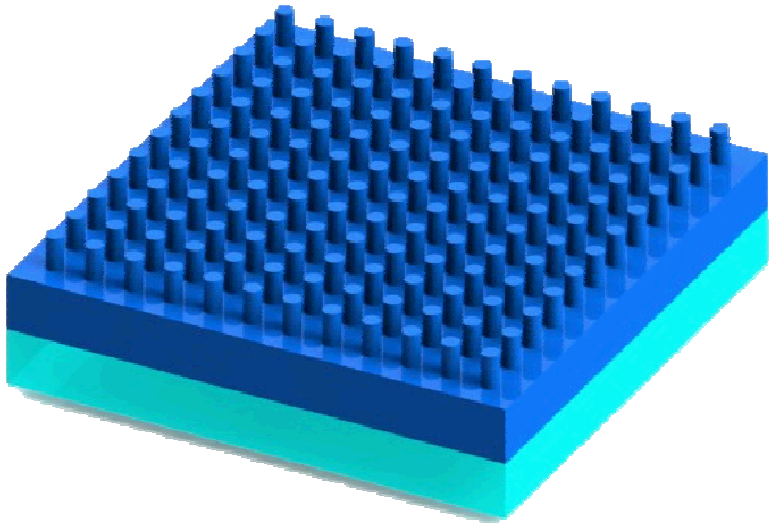

Odom et al., Improved Pattern Transfer in Soft Lithography Using Composite Stamps, *Langmuir* **2002,** *18,* 5314-5320




Gitlin et al., Rapid replication of master structure by double casting with PDMS, *Lab Chip*, 2009 Oct 21; 9(20):3000-2.

# Concept

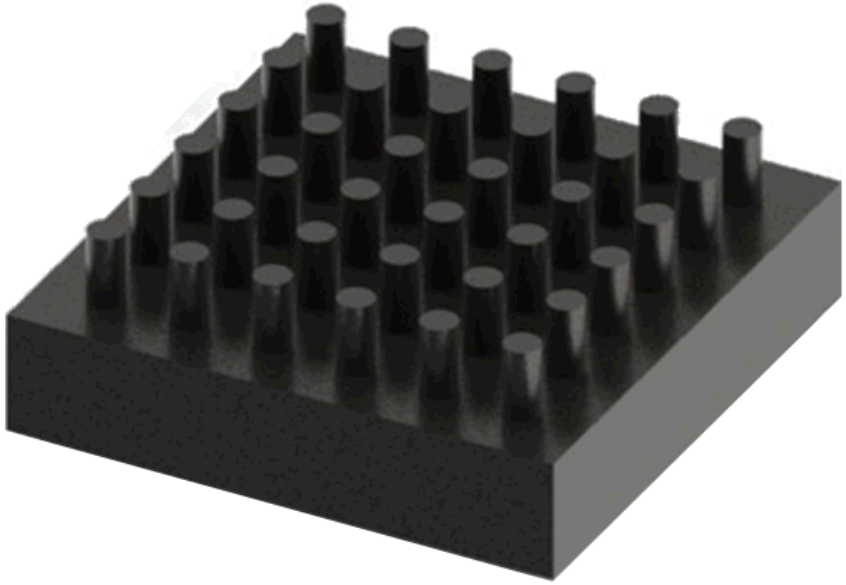
- **Create arrays of 150nm-nanoholes and nanoposts via double casting**
  - **Composite Stamp**
    - **H-PDMS as mold material**
    - **S-PDMS as mold support**



  - **Molecular Vapor Disposition (MVD) as passivation process**
    - $O_2$ plasma was not used

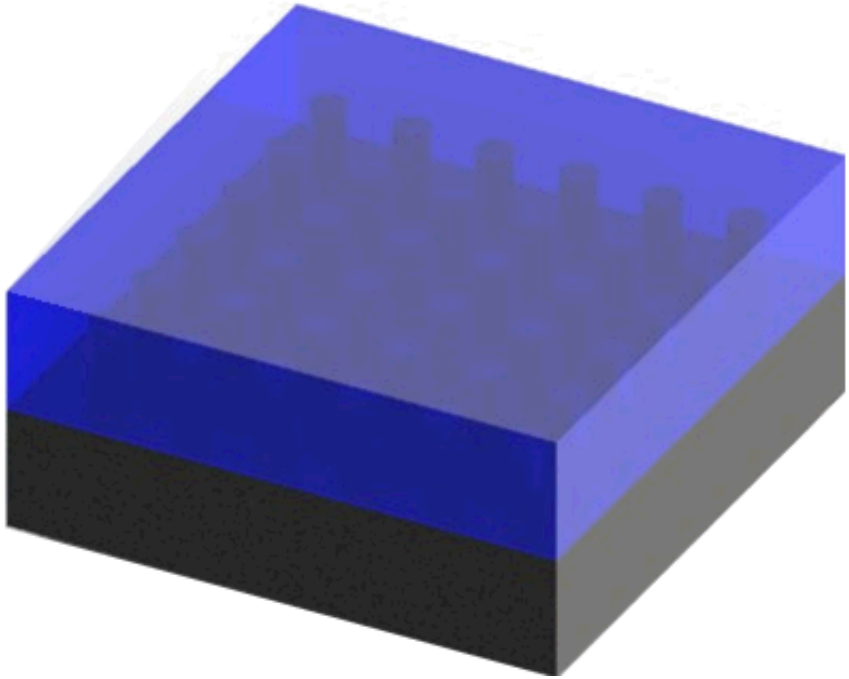
# Fabrication

- Silicon Master Template
  - 0.5cm x 1cm nanopost array



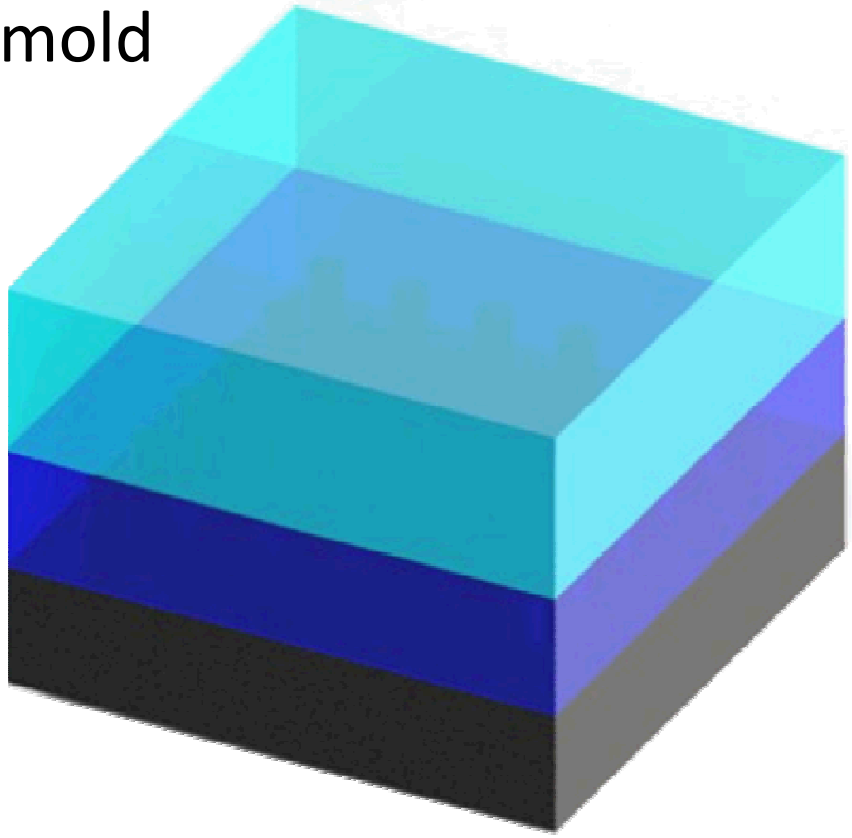
# Fabrication

- Pour Hard PDMS (h-PDMS)
  - Less Viscous
  - defined nanoholes



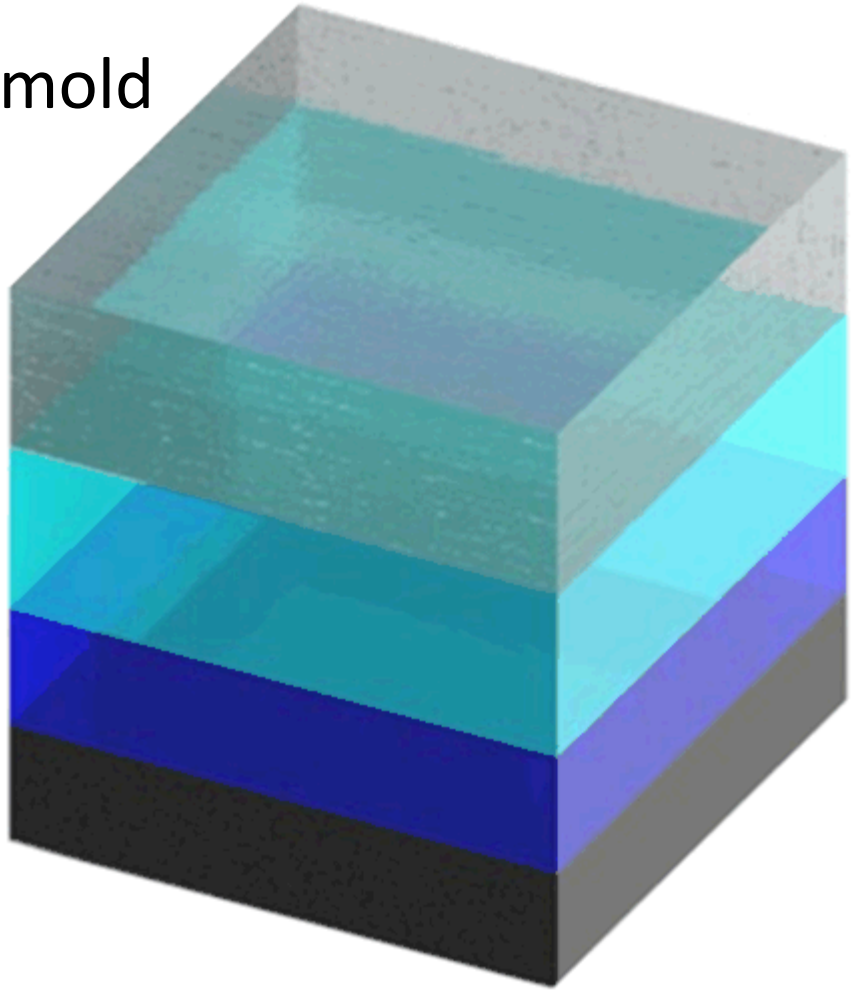
# Fabrication

- Pour s-PDMS
  - More flexible
  - Support mold



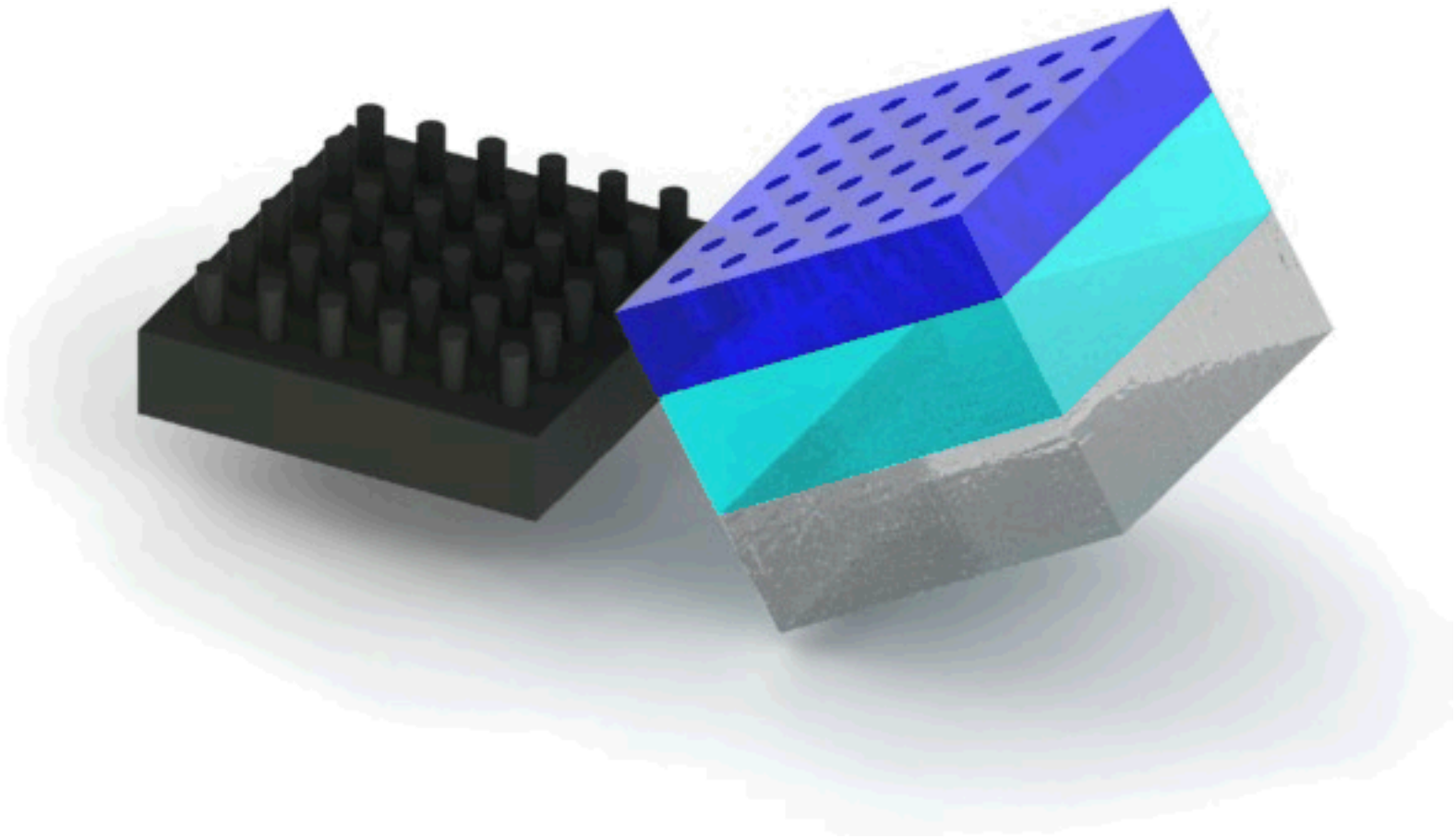
# Fabrication

- Glass slide
  - Support mold



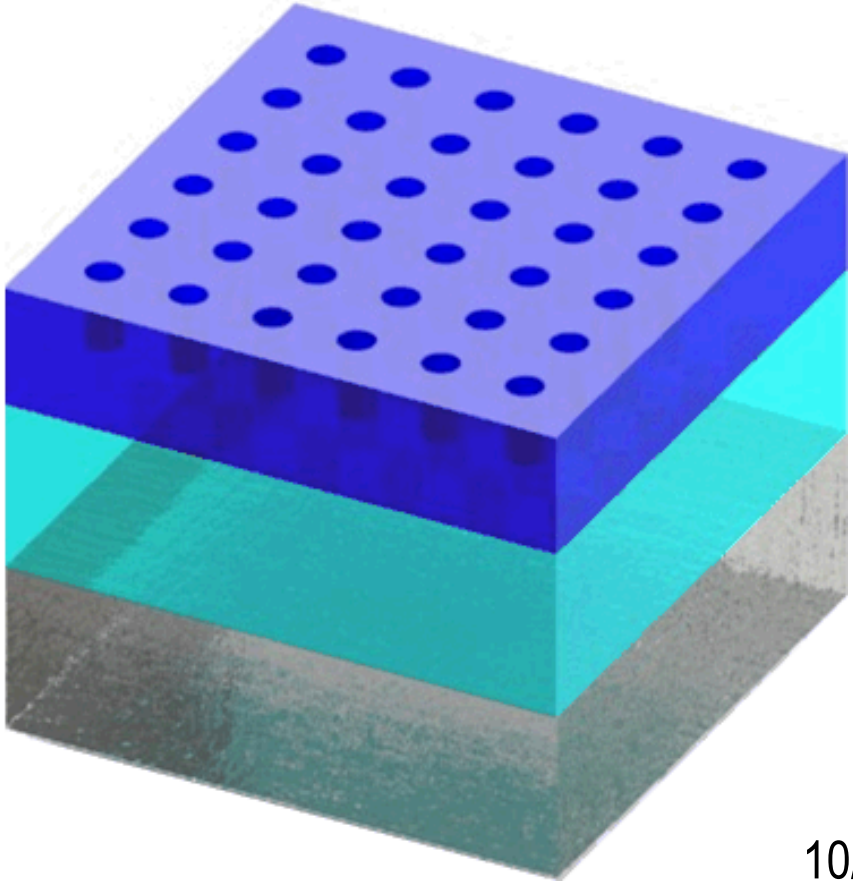
# Fabrication

- Demold PDMS template



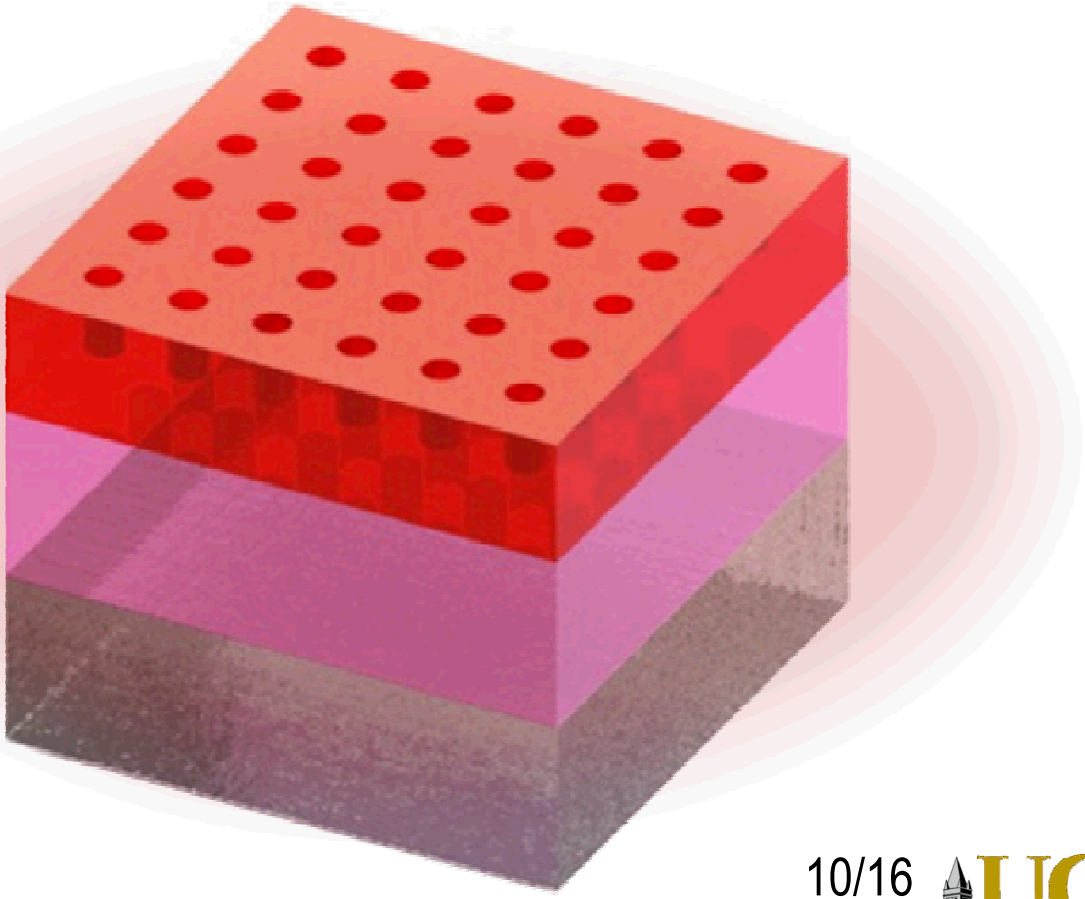
# Fabrication

- Demold PDMS template



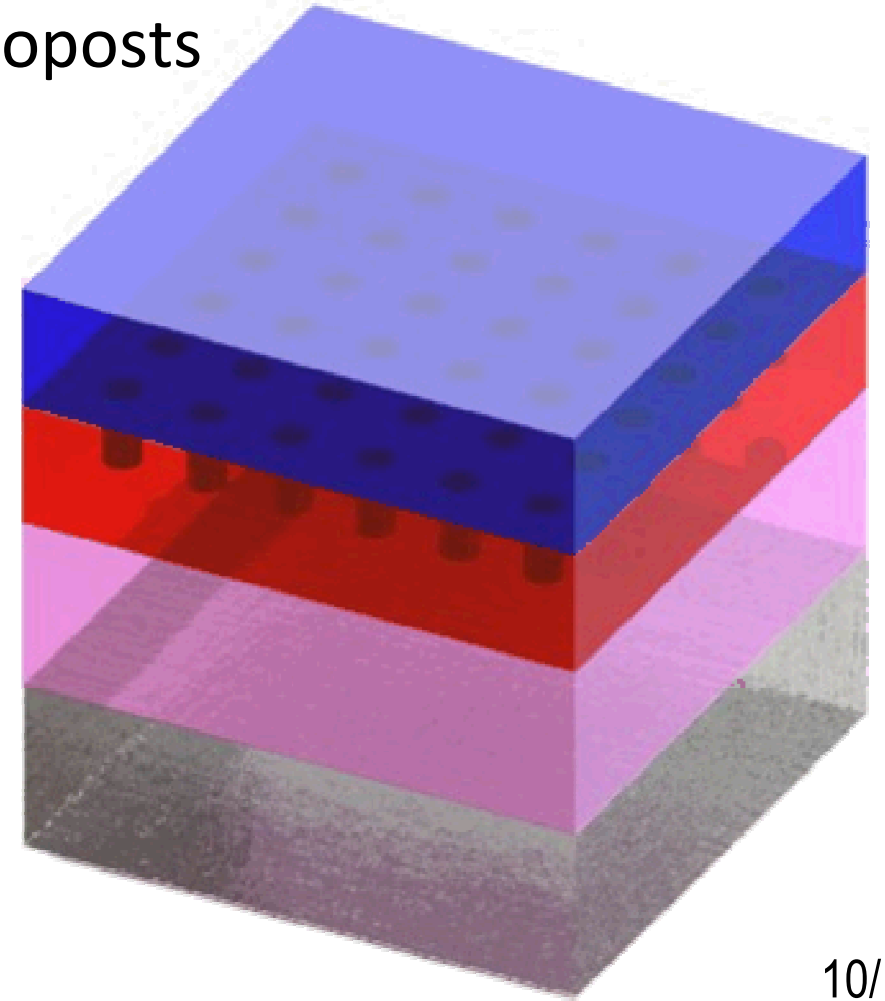
# Fabrication

- Passivate the PDMS template using Nanonex Ultra-100 MVD process.



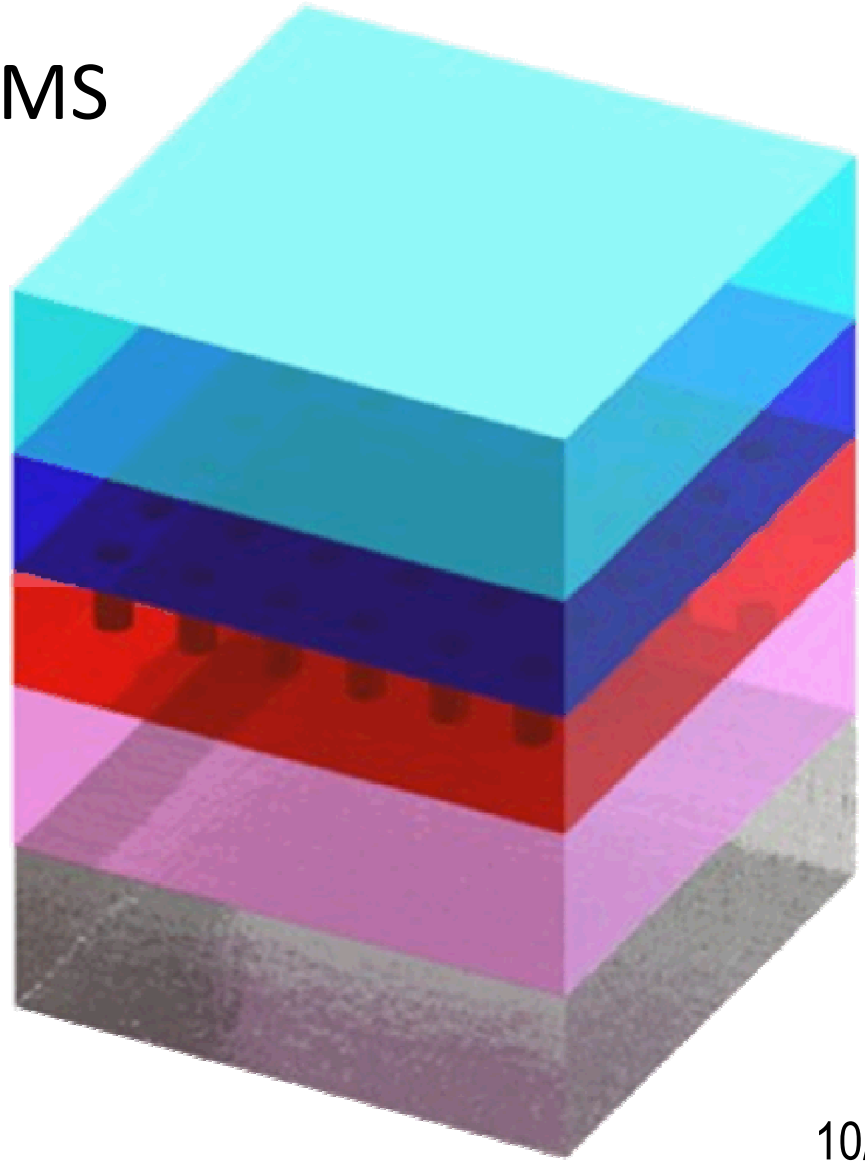
# Fabrication

- Pour h-PDMS
  - Stiff nanoposts



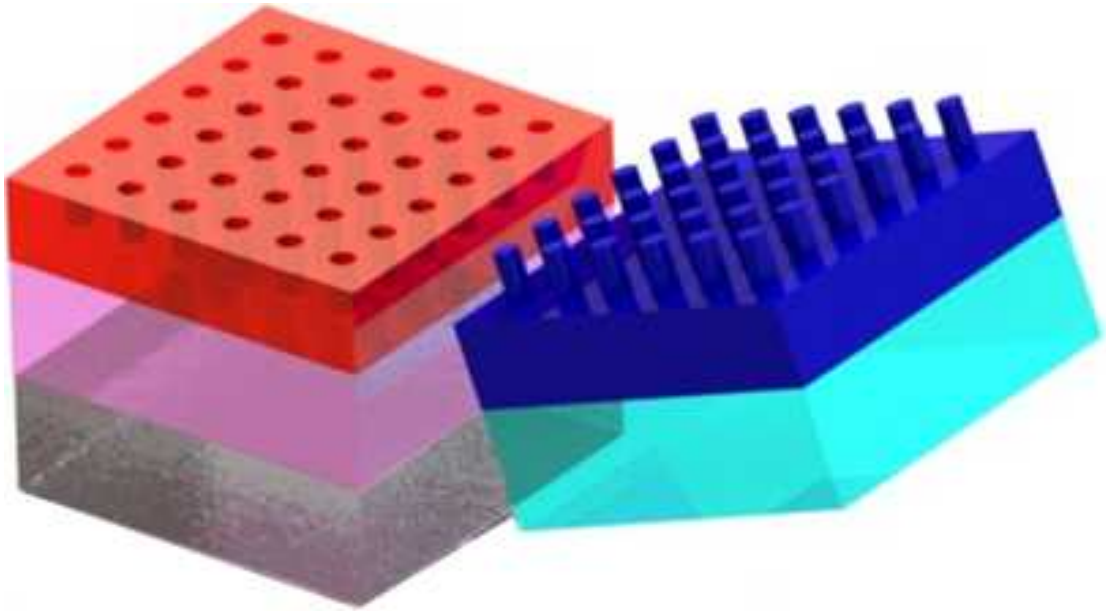
# Fabrication

- Pour s-PDMS



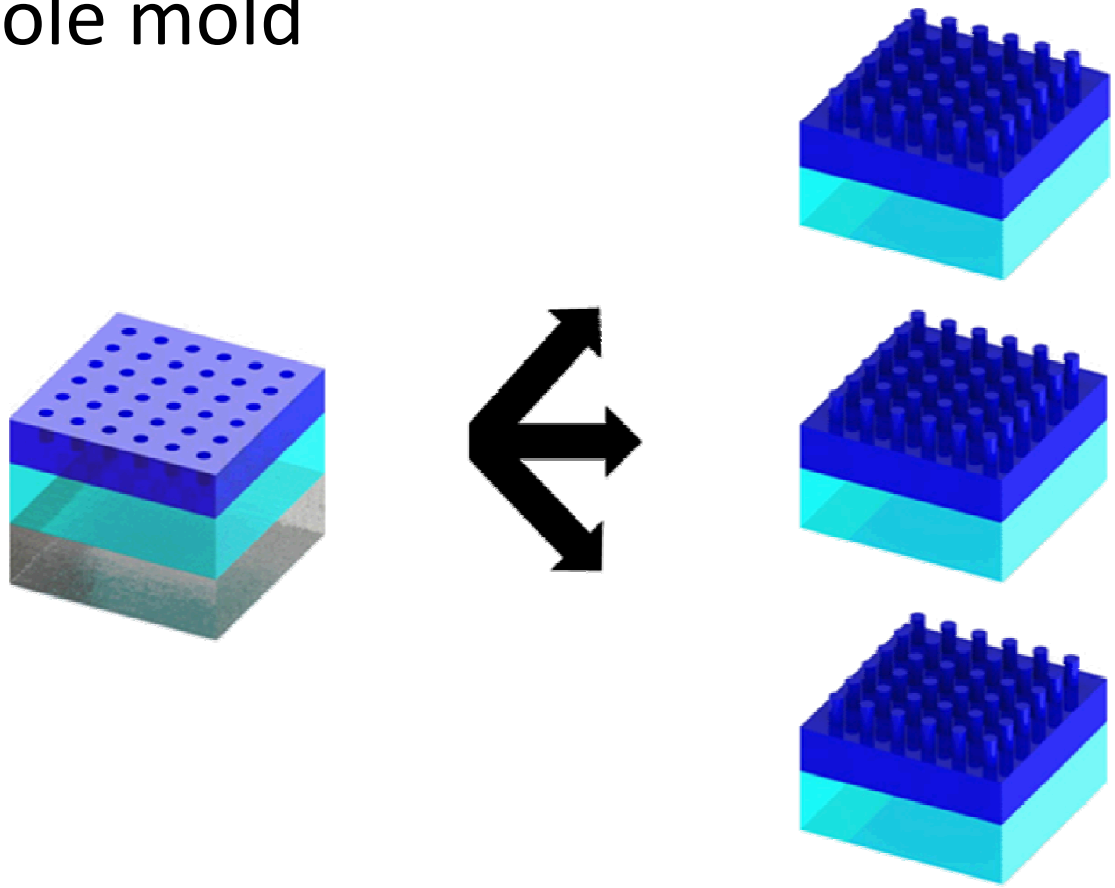
# Fabrication

- Demold PDMS nanopost template



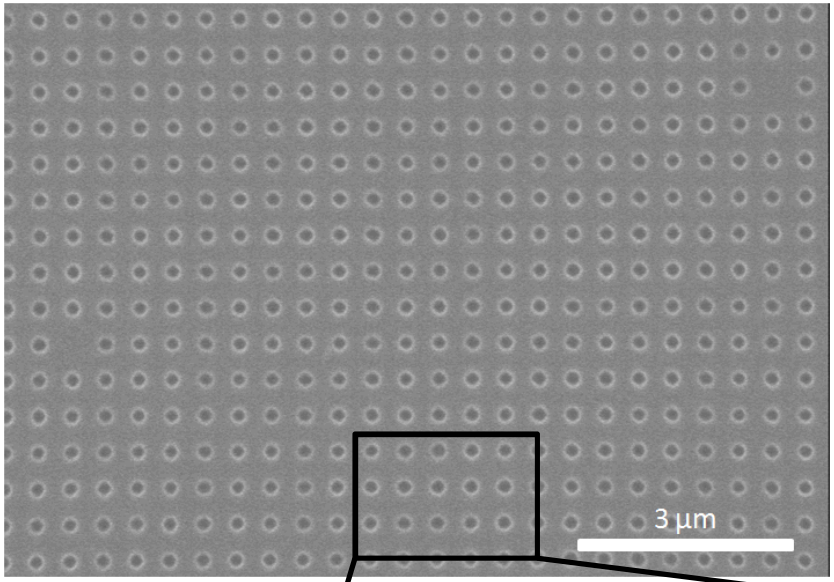
# Fabrication

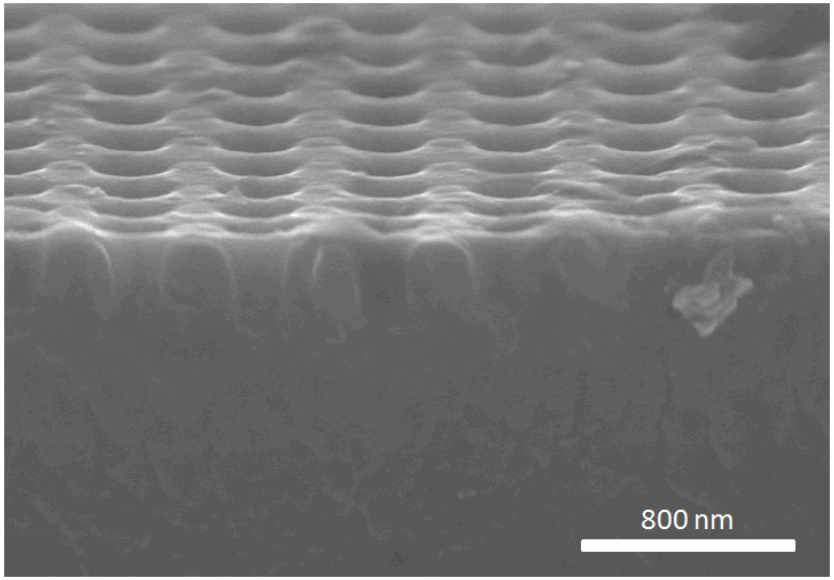
- Process was repeated with the same PDMS nanohole mold

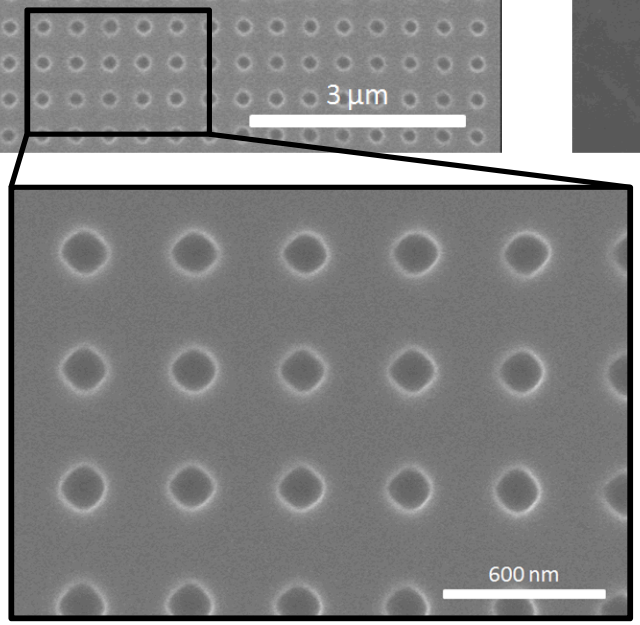


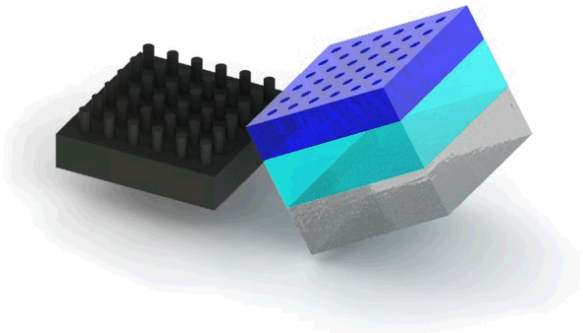
# Results

- SEM images of the PDMS 150nm-nanohole template



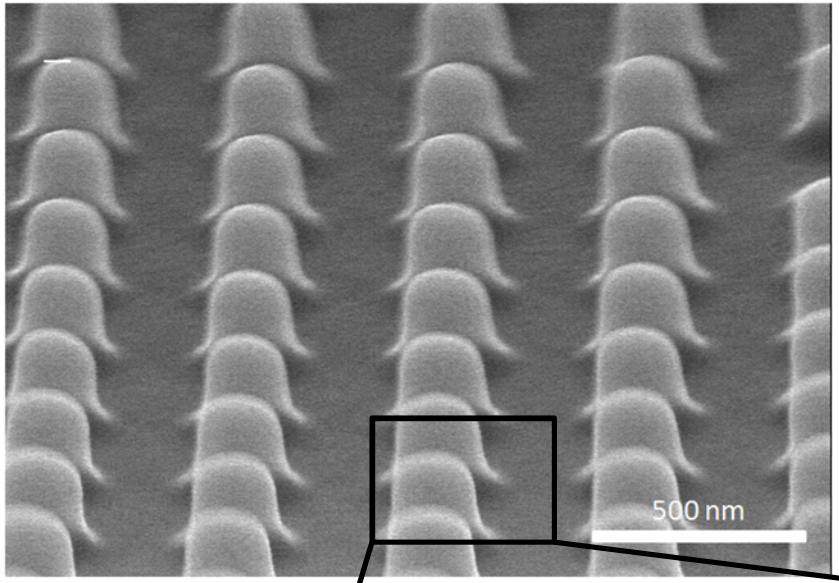



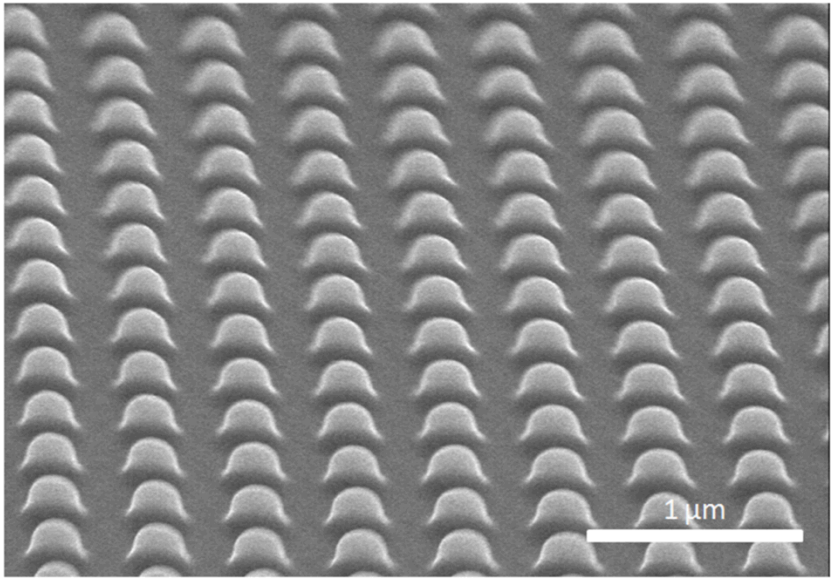



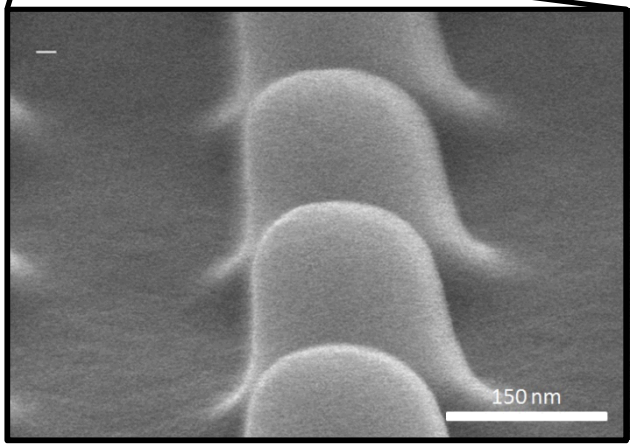



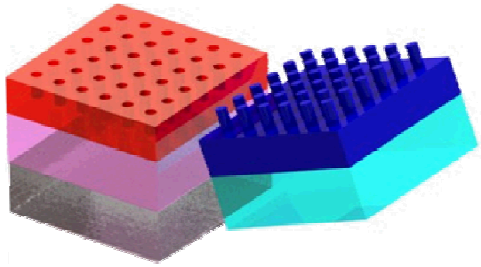
# Results

- SEM images of the PDMS 150nm-nanopost template



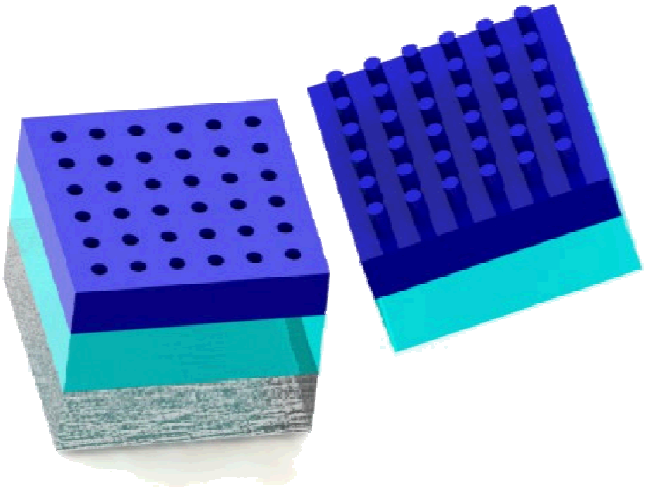



# Conclusions

- Double Casting was performed to create multiple arrays with nanostructures
  - PDMS composite stamp allows the replication of nanoholes and nanoposts
  - MVD passivation allows PDMS mold to be reused multiple times



# Questions?