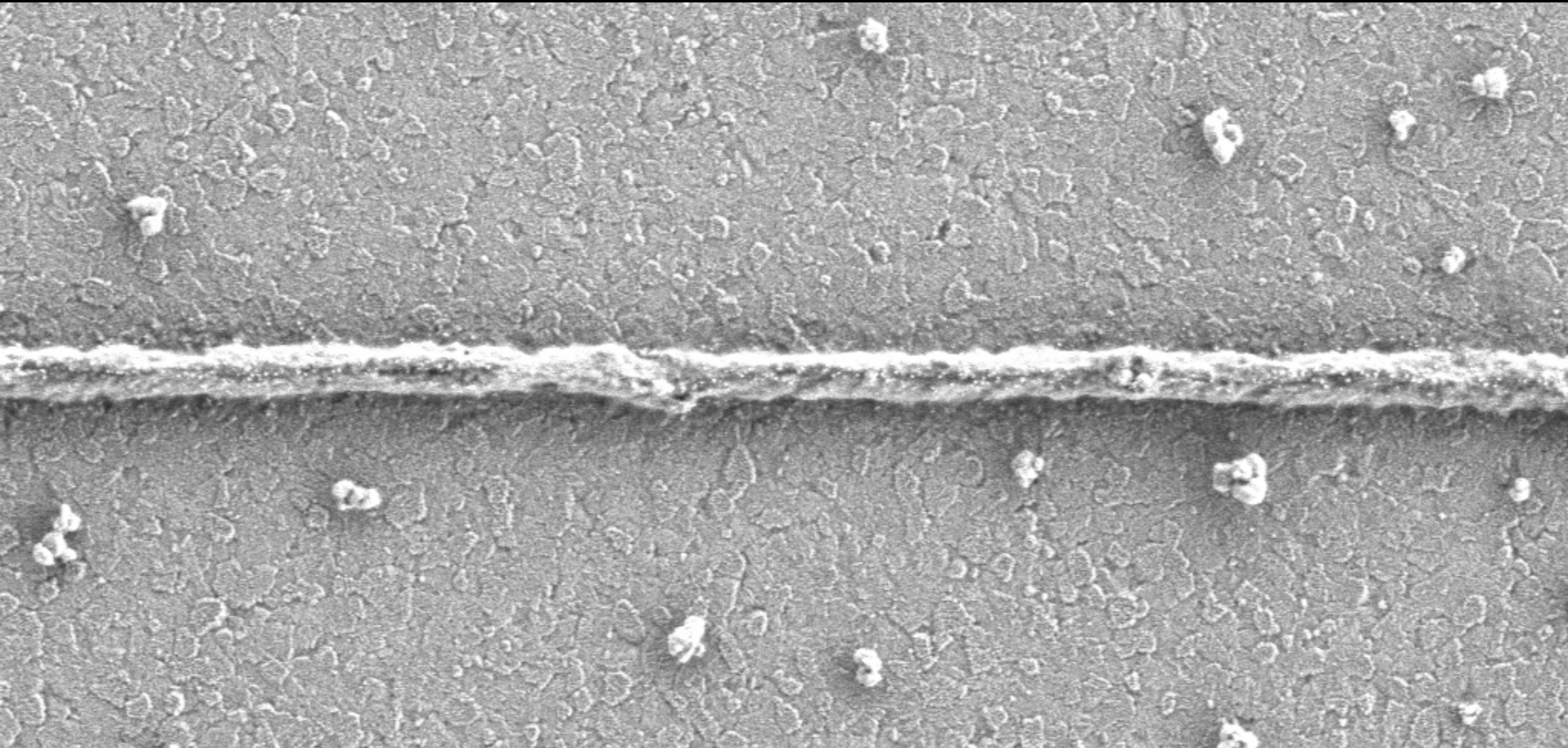


three-dimensional silver nanofabrication through multiphoton photoreduction



kevin vora

seungyeon kang, shobha shukla, eric mazur
photonics west 1/24/2012

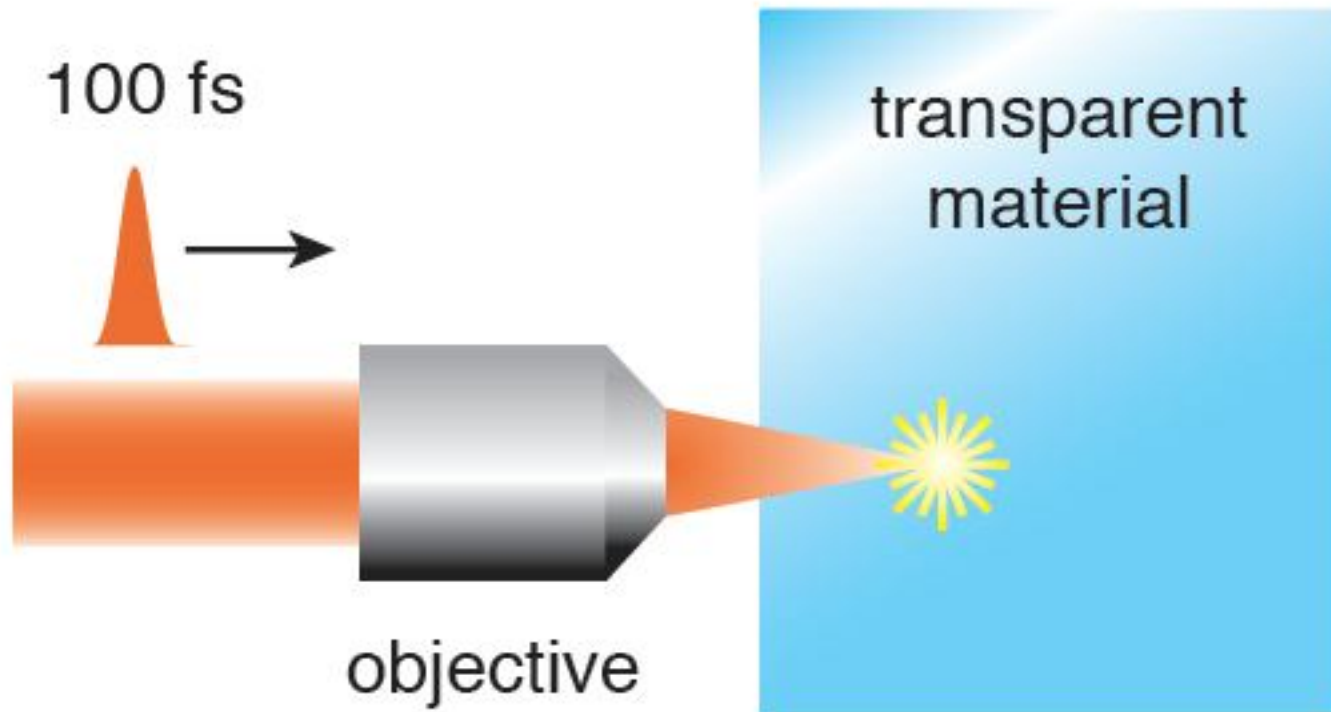


fs-laser nanofabrication

fs-laser nanofabrication

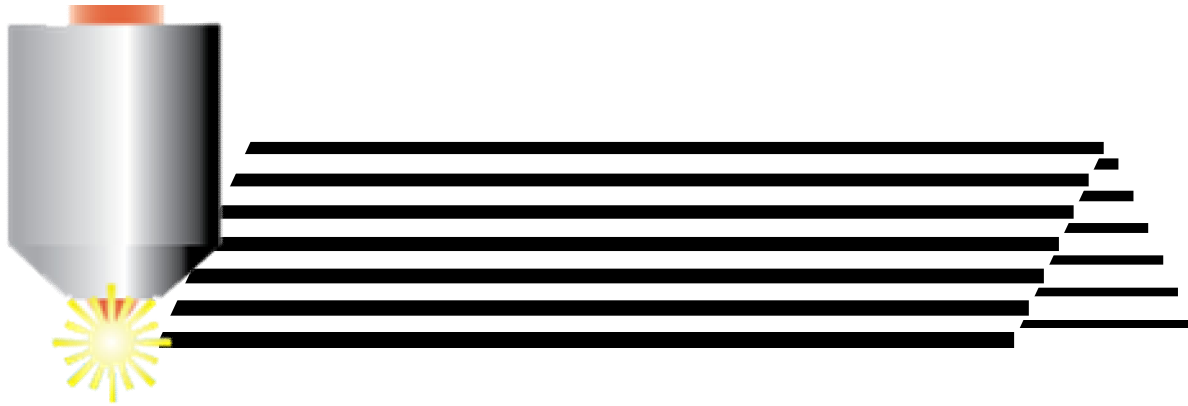
- ability to modify a material from within
- small amounts of energy
- inherently 3D

how?

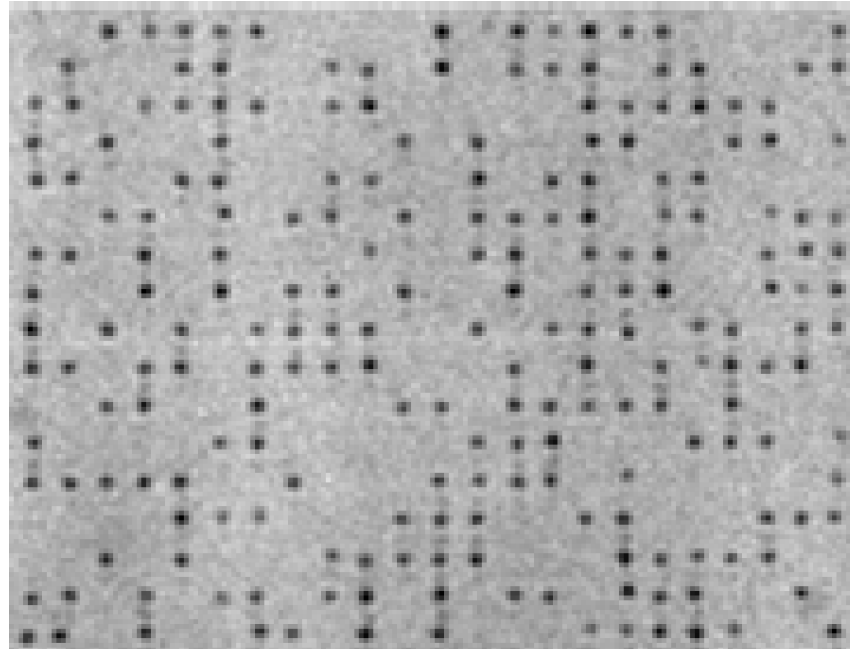


Opt. Lett. **21**, 2023
(1996)

raster scanning in 3D

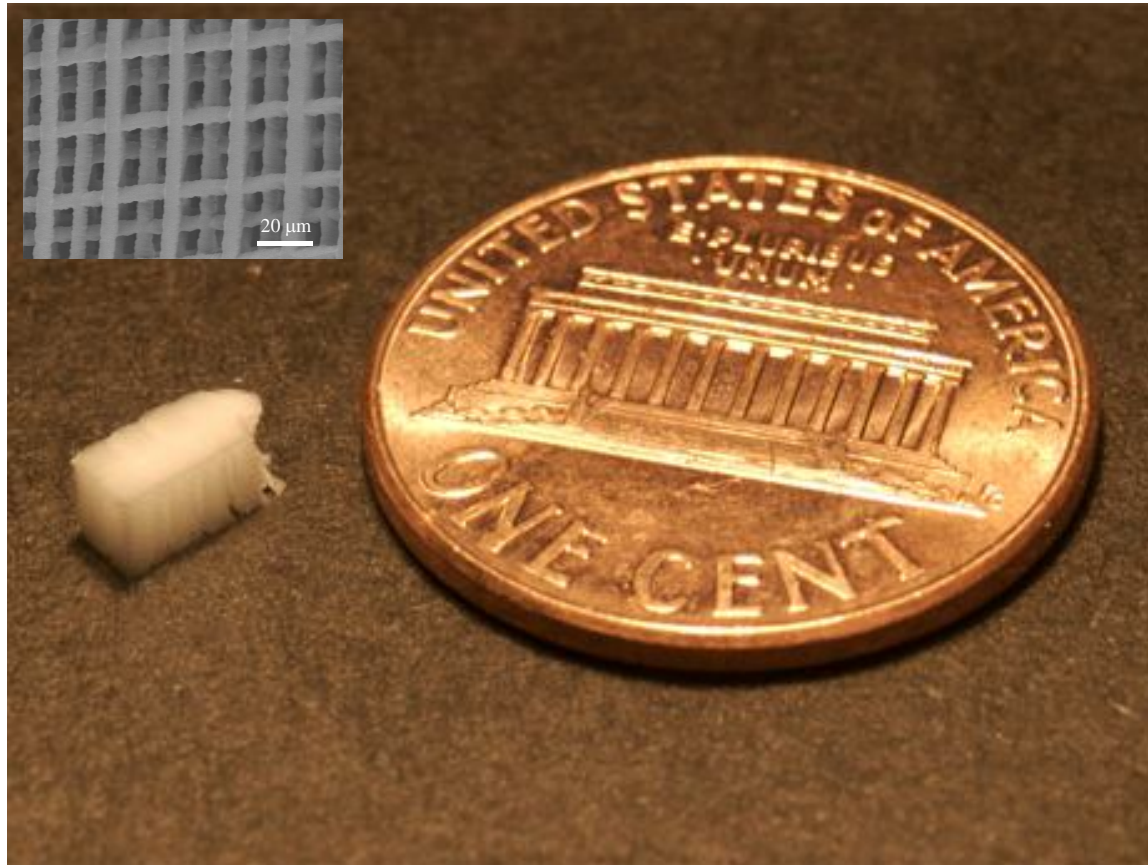


glasses



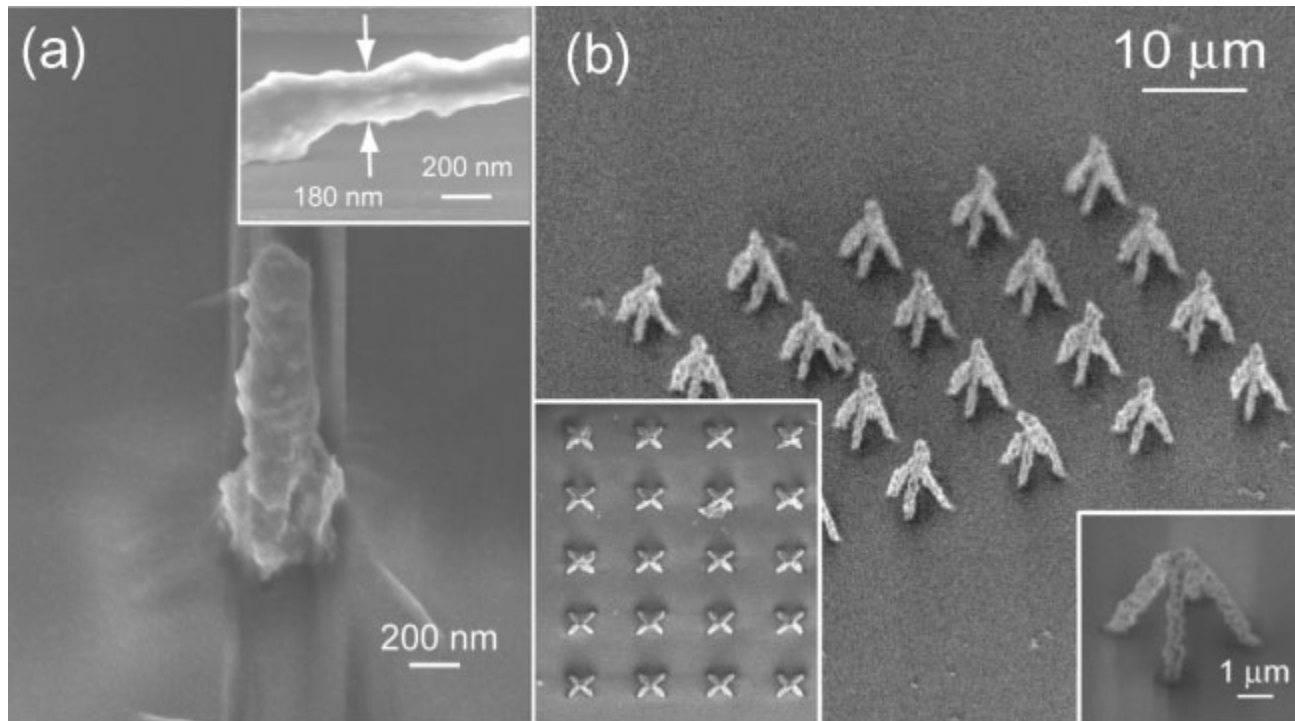
Opt. Lett. **21**, 2023
(1996)

polymers



Adv. Mat. **20**, 4494
(2008)

metals



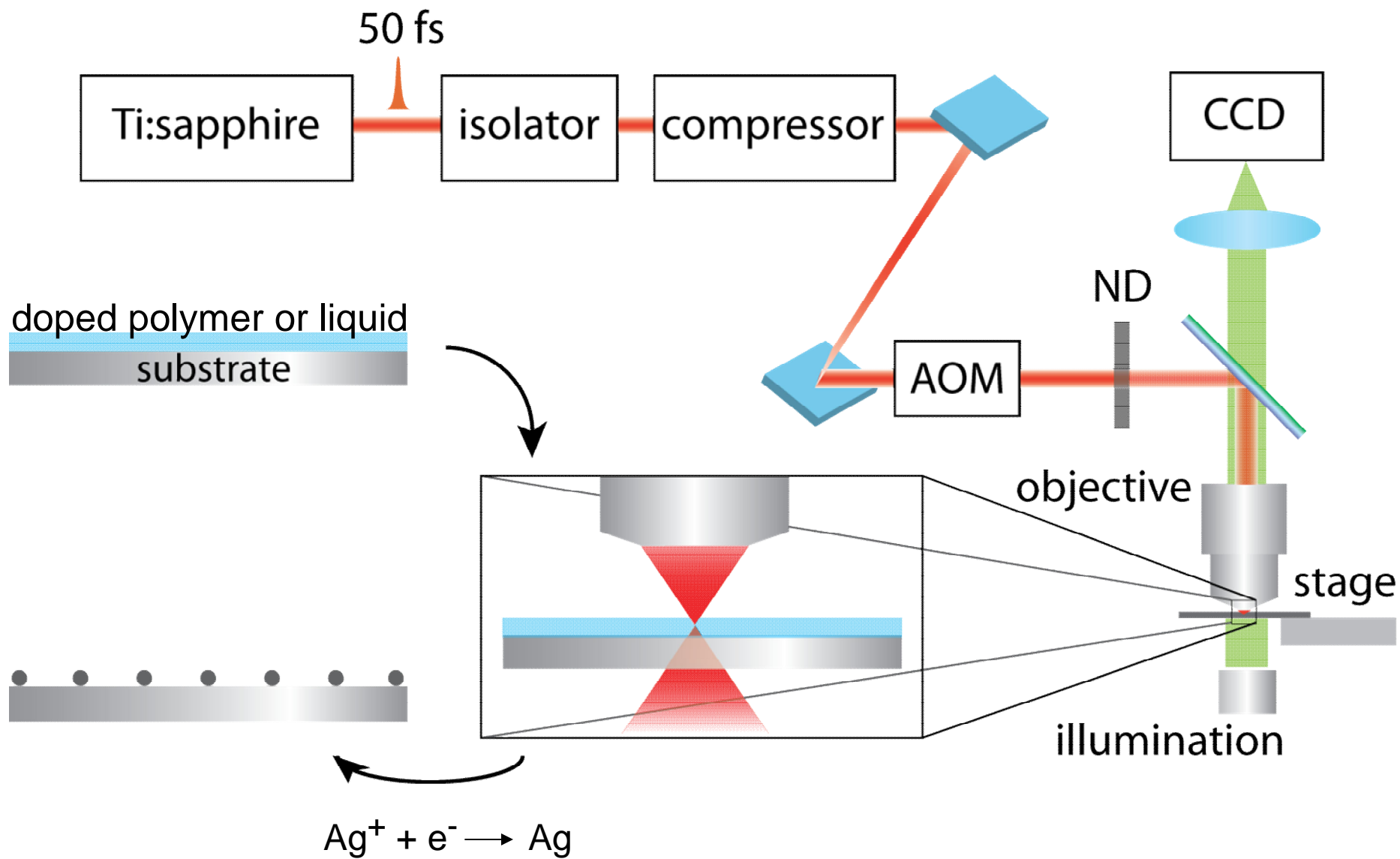
Y-Y Cao et al.,
Small **5**, 1144
(2009)

nanofabrication of metals

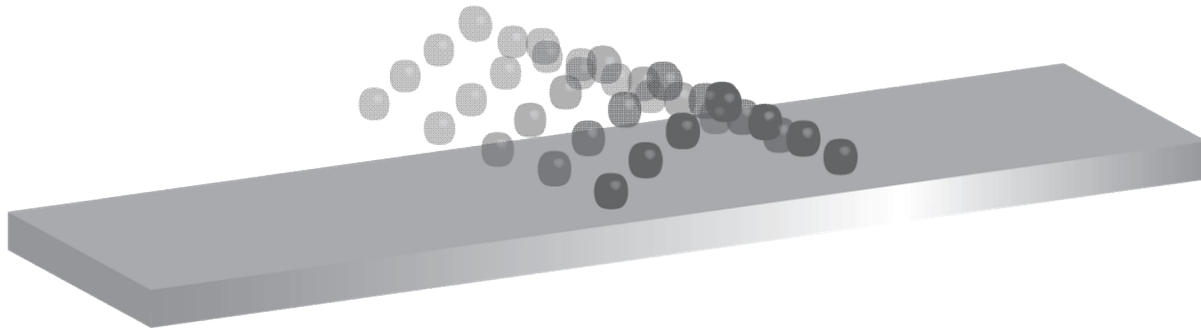
nanofabrication of metals

why?

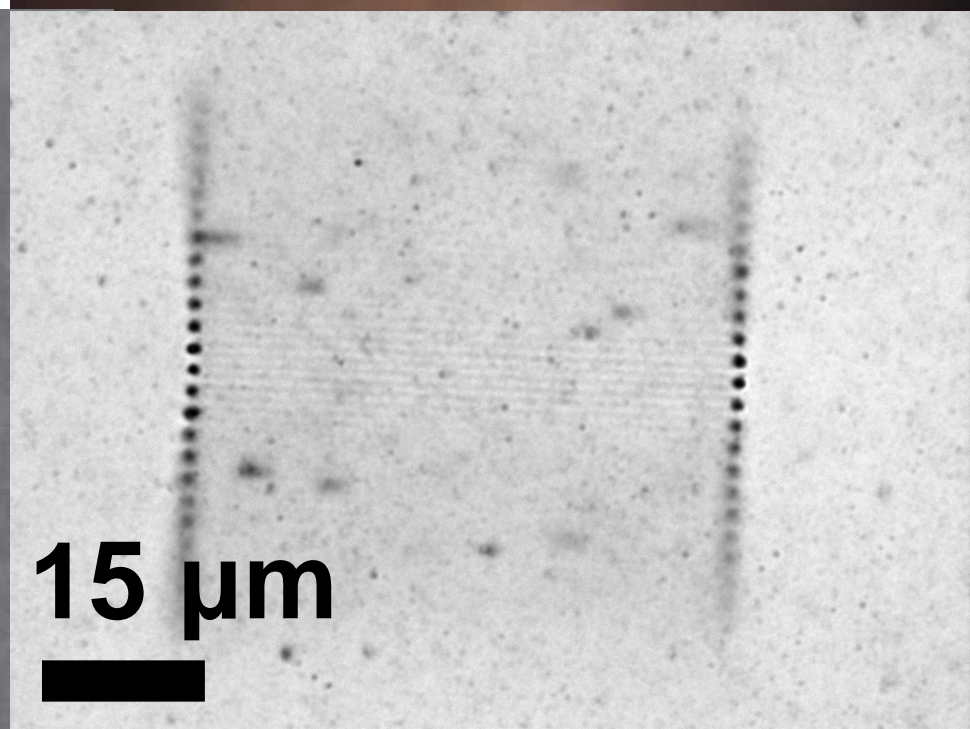
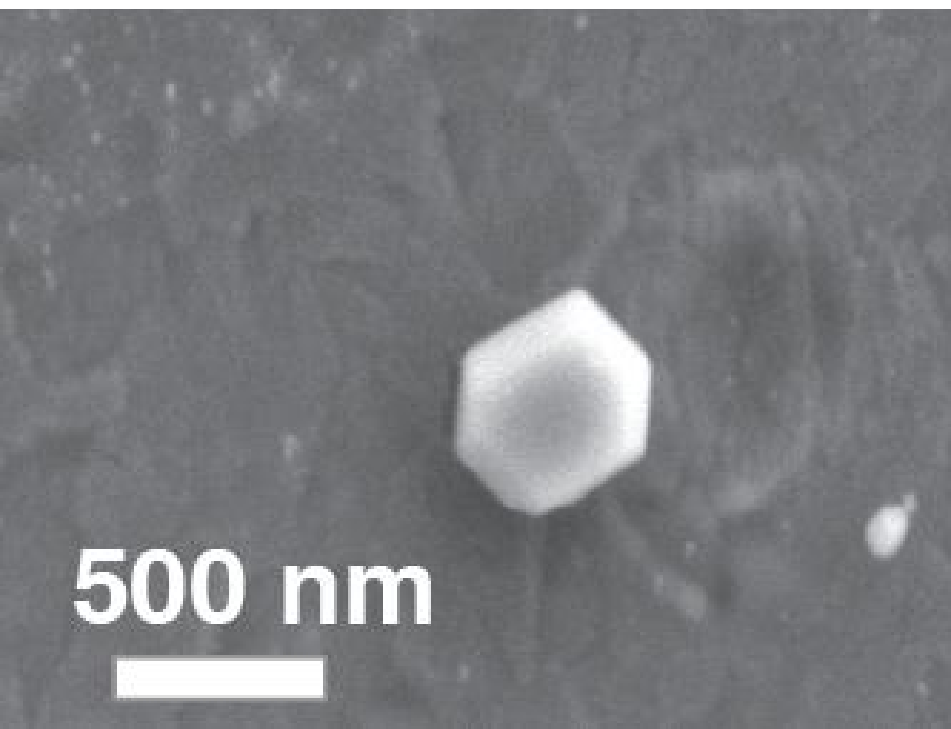
- metamaterials
- microelectronics
- biosensing



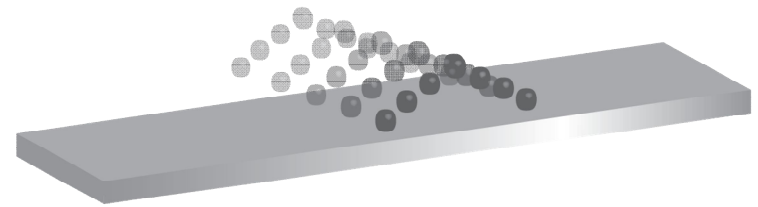
how about this structure?



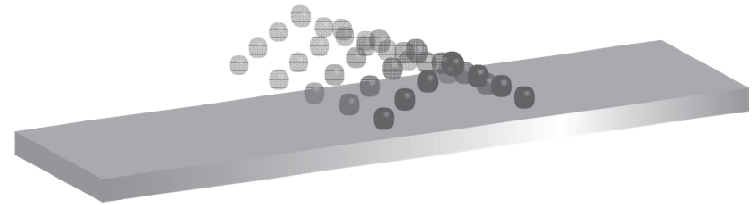
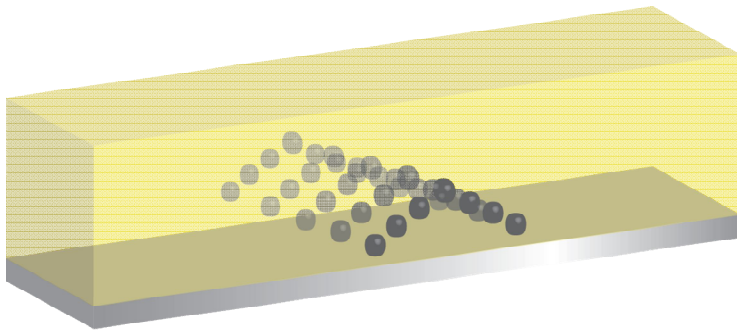
overview



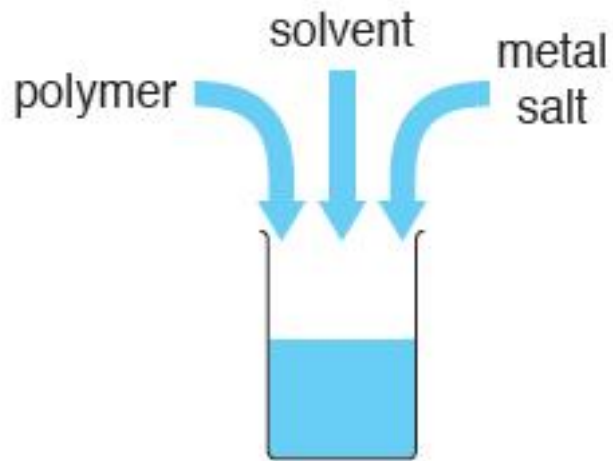
how to make this structure?

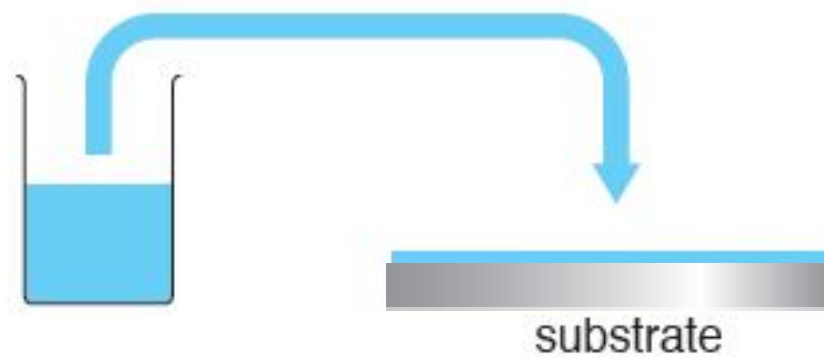
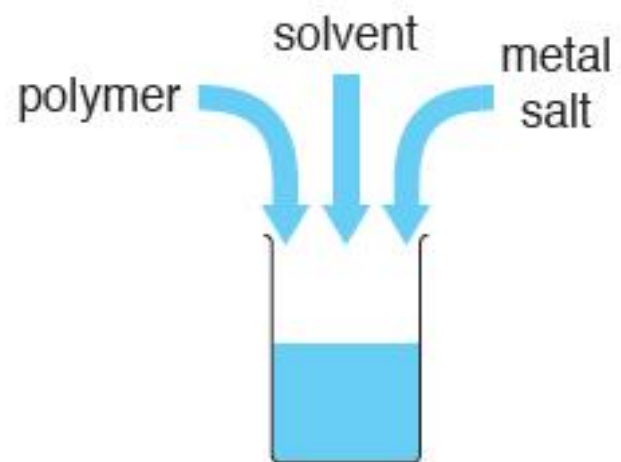


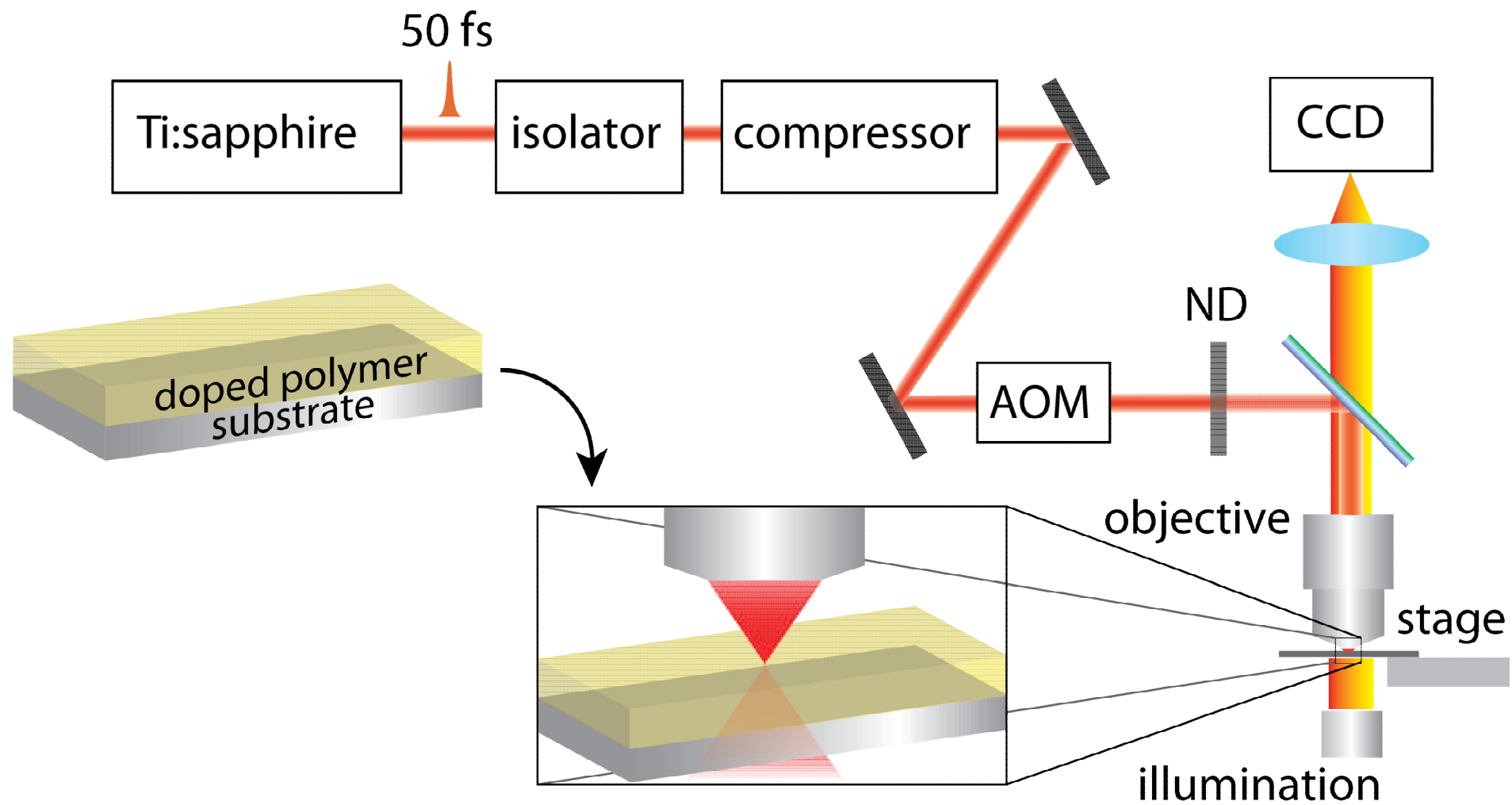
how to make this structure?

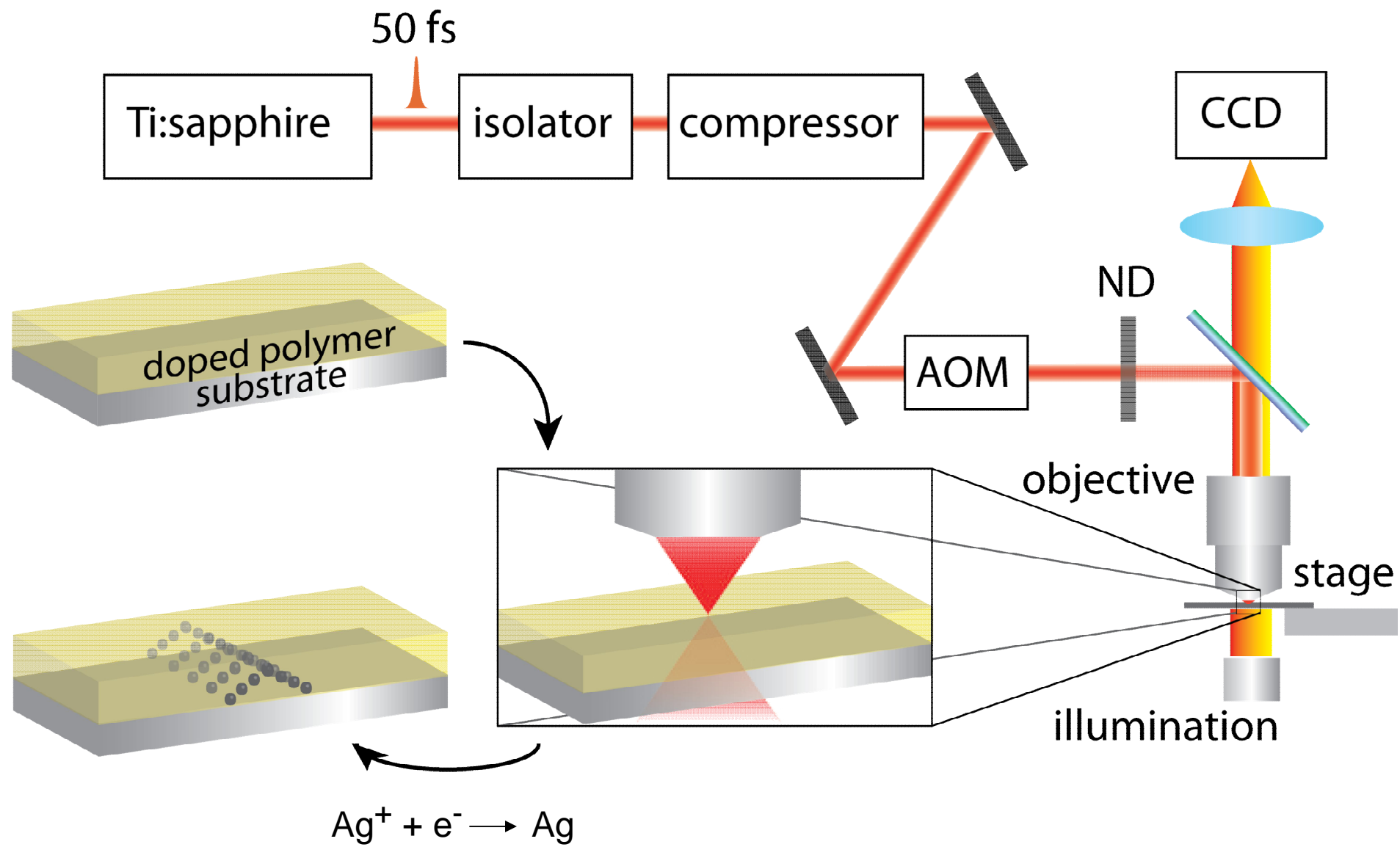


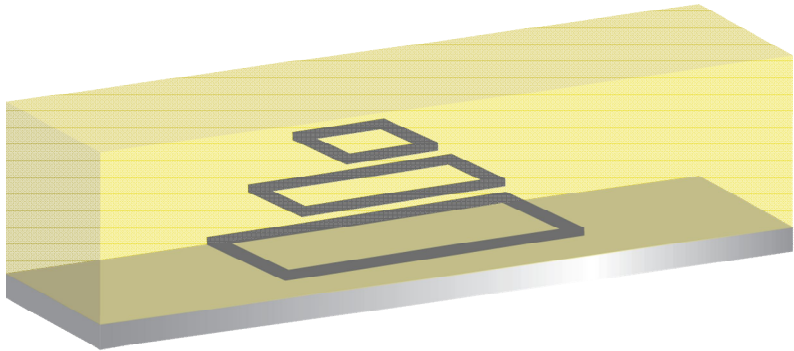
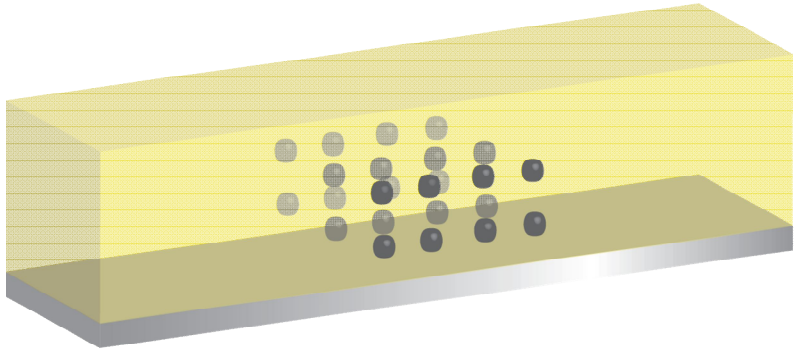
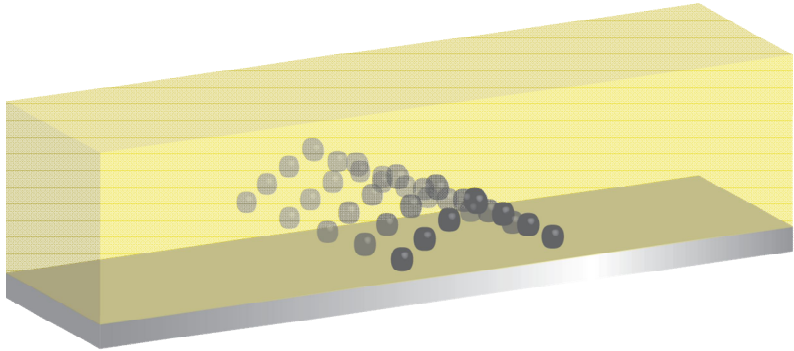
sample preparation



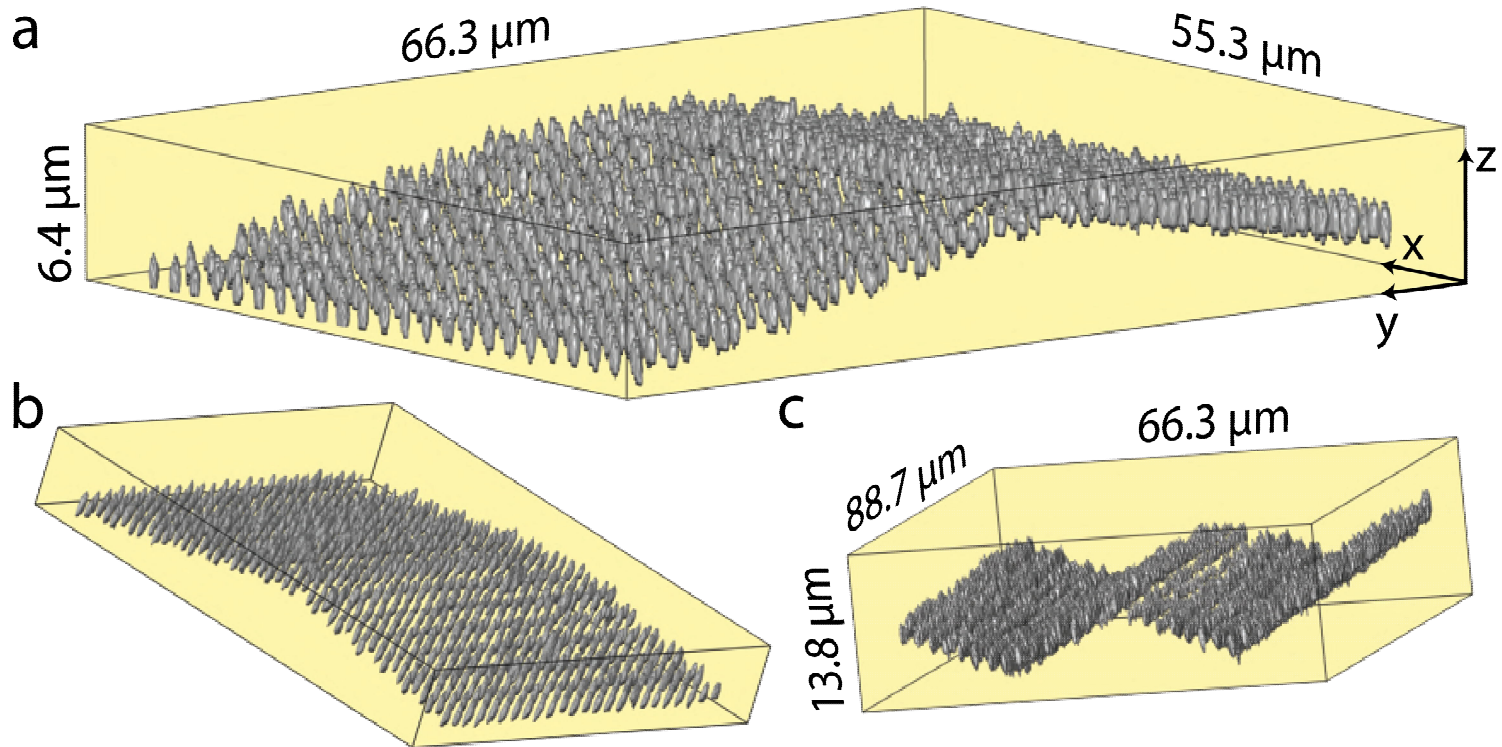


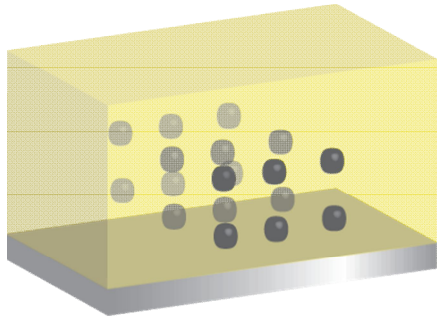


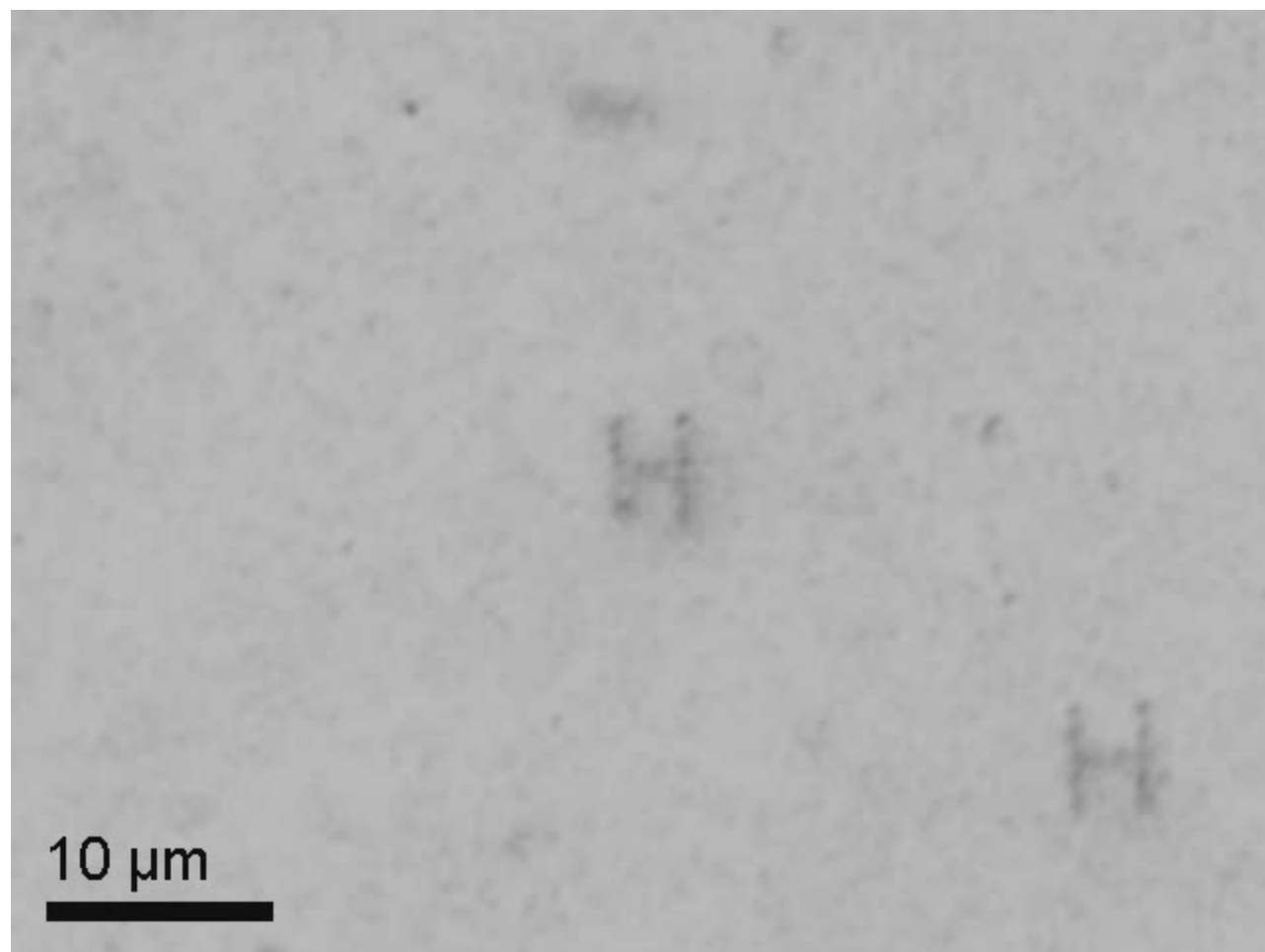
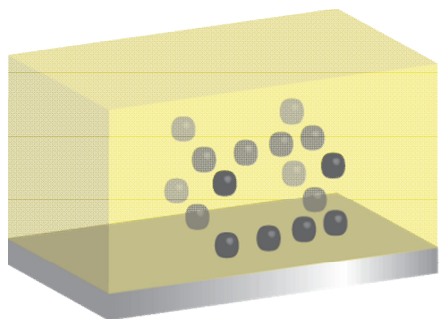


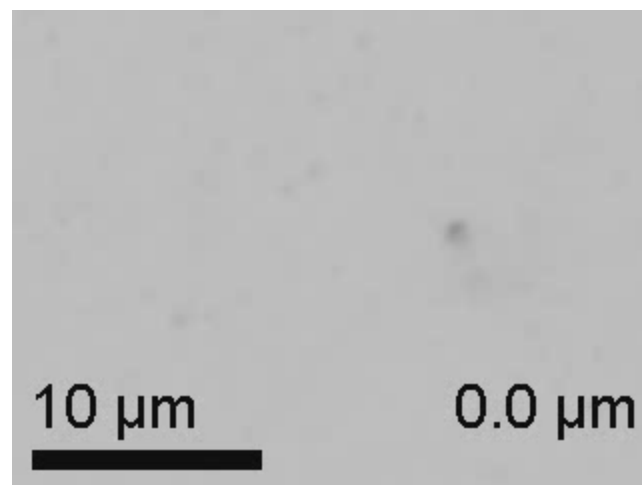
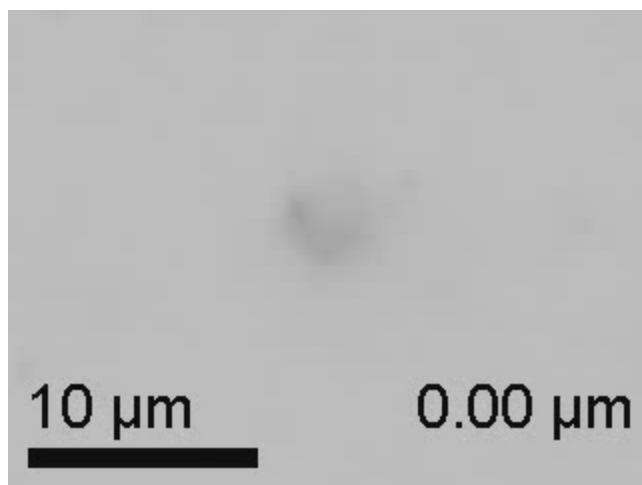


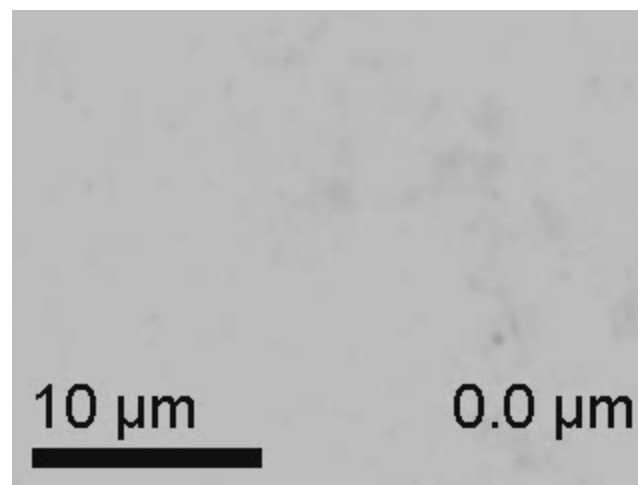
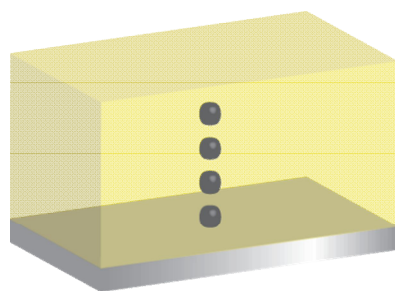
3D rendering







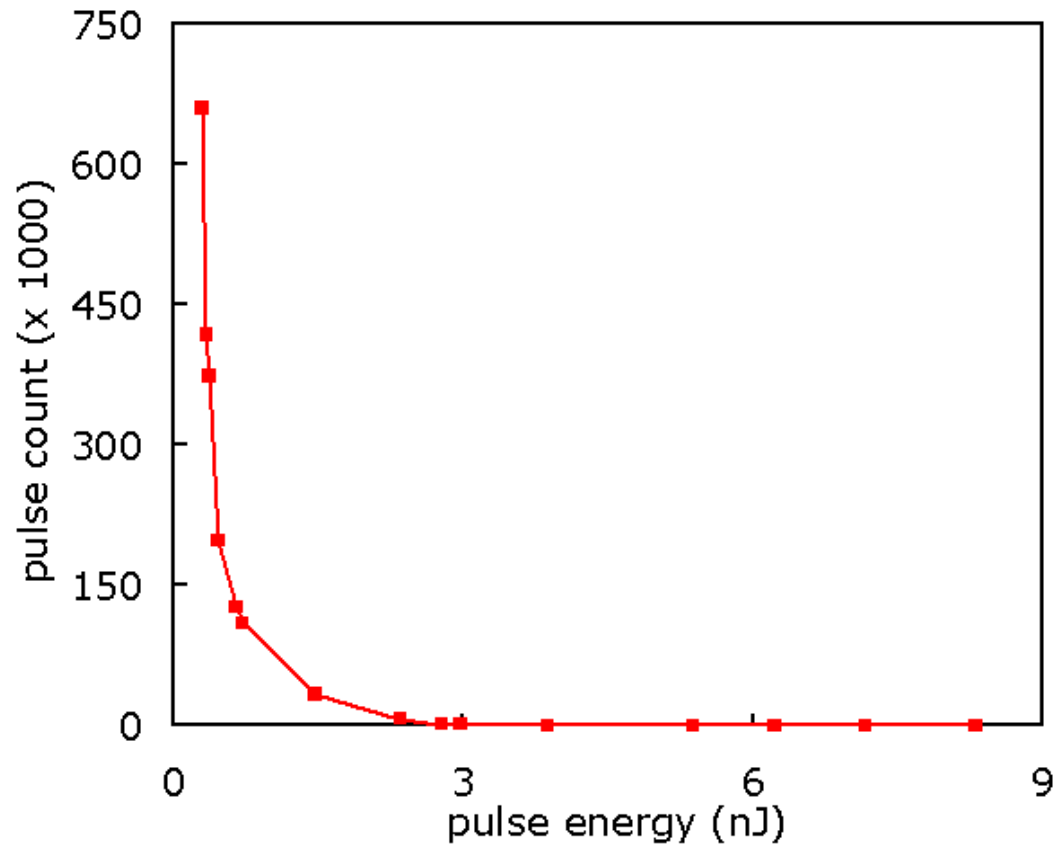




fabrication parameters

- $> 100 \mu\text{m/s}$
- $< 1 \text{ nJ}$
- single step

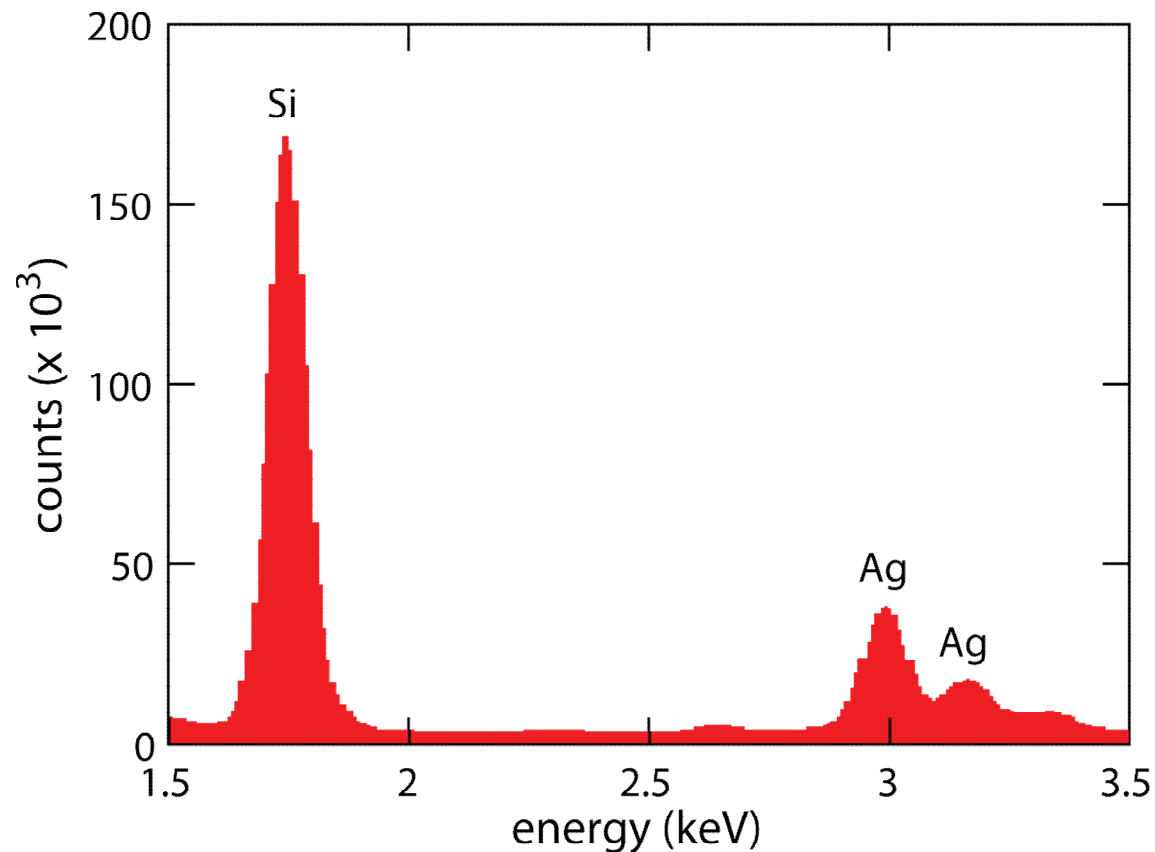
pulse count vs. pulse energy



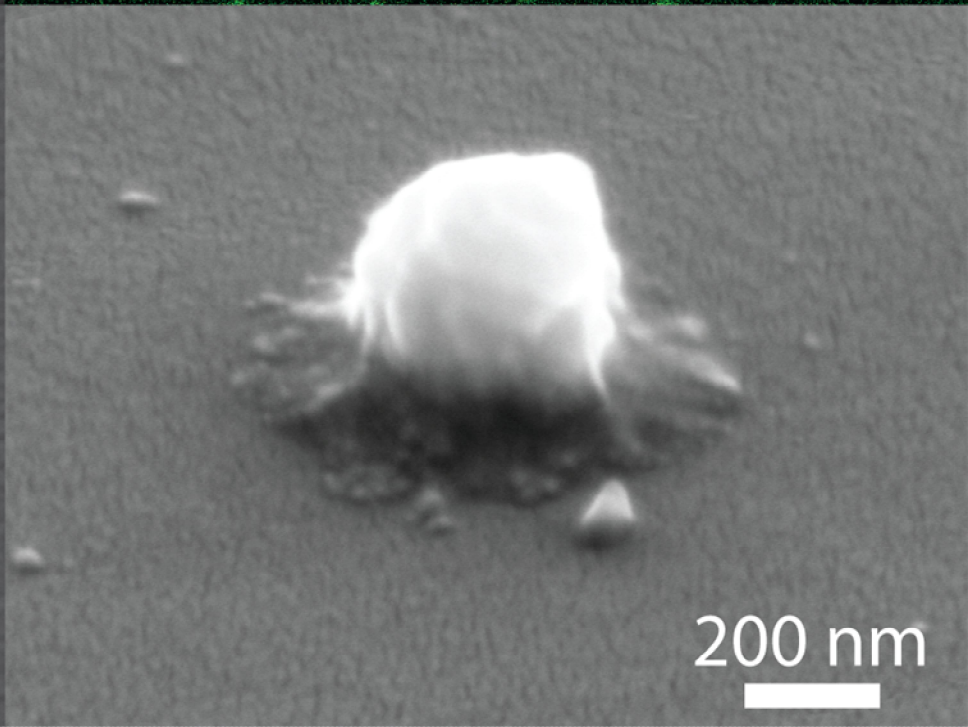
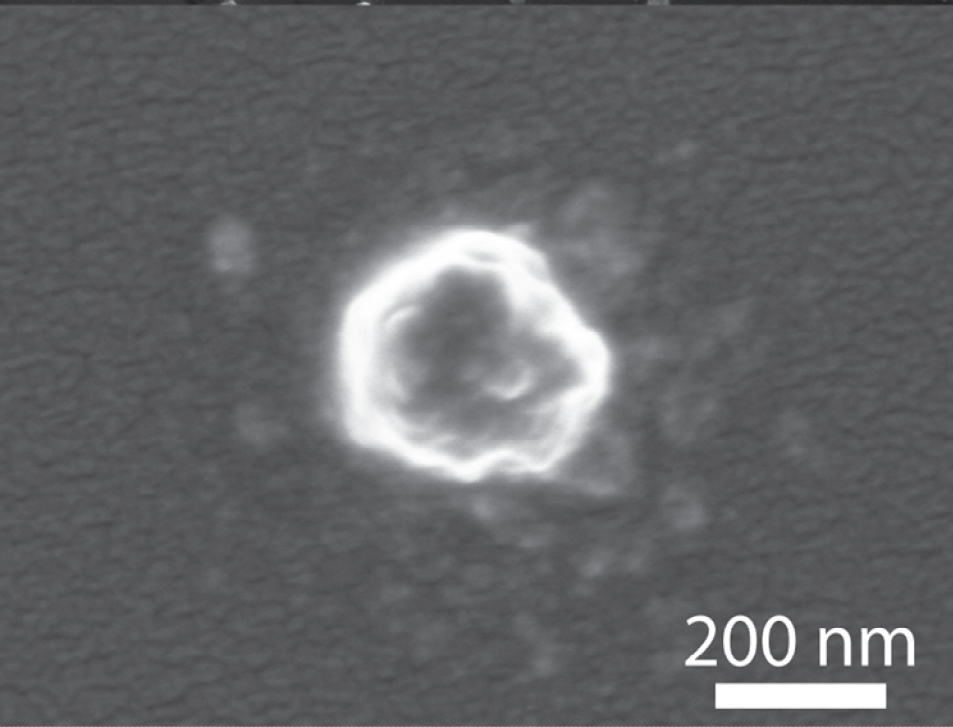
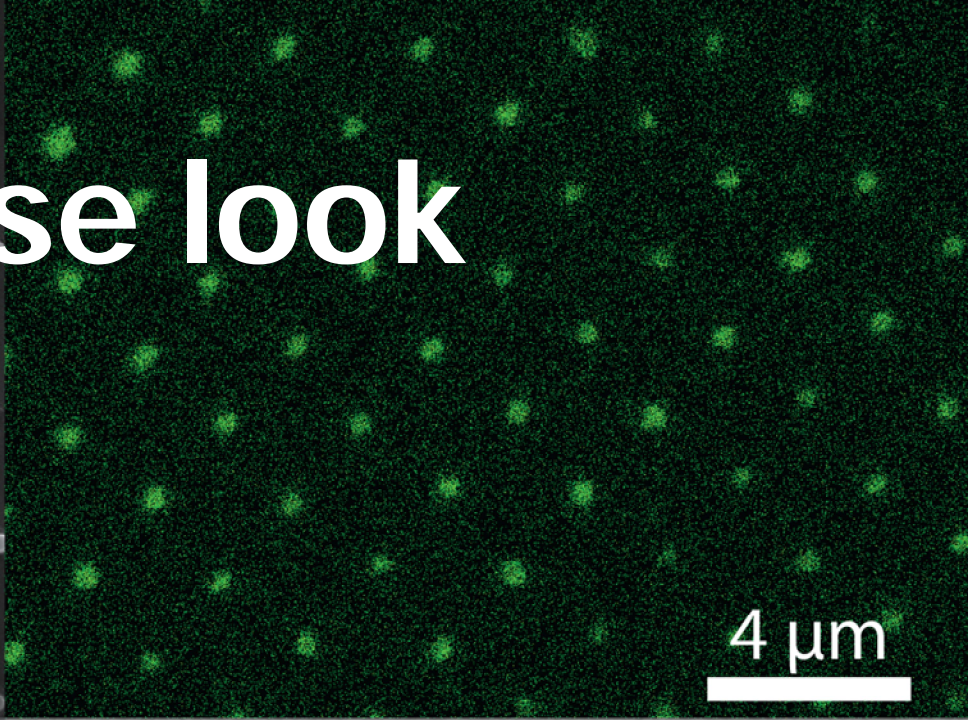
characterization in 2D



energy dispersive x-ray spectroscopy



taking a close look



taking a closer look

20 nm

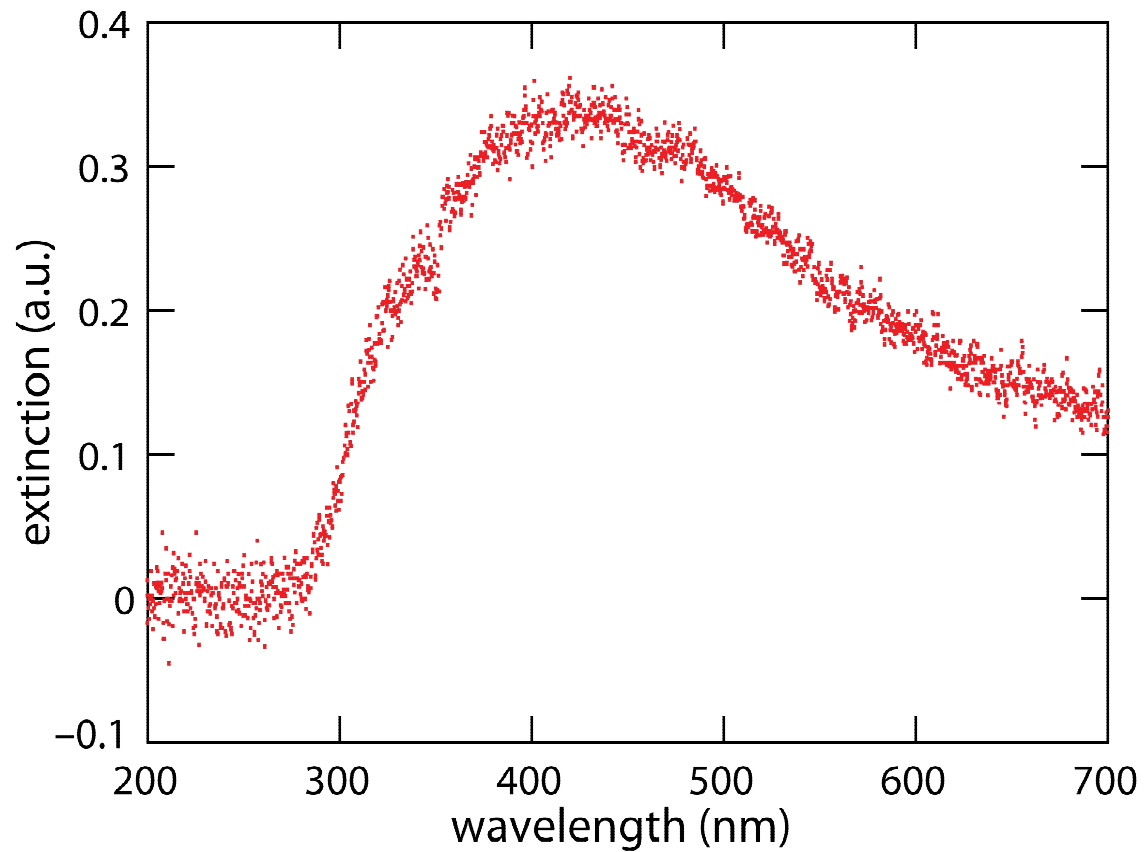


even closer

1 nm



extinction



summary

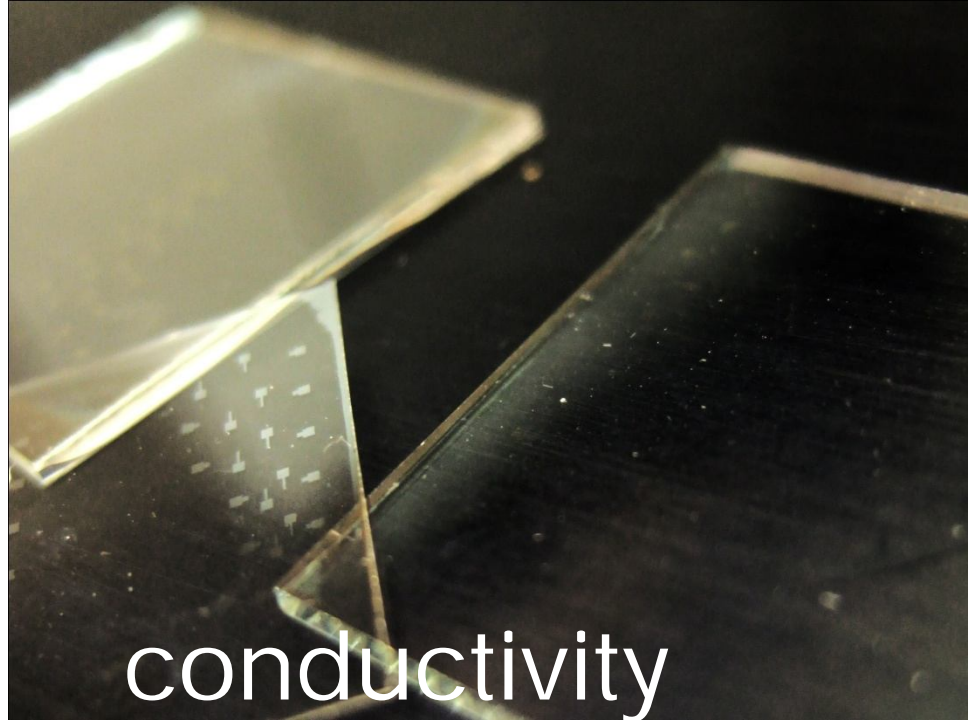
- direct laser writing of silver
- 3 dimensional
- embedded in polymer matrix
- disconnected structures
- can be stacked
- sub-300 nm

next

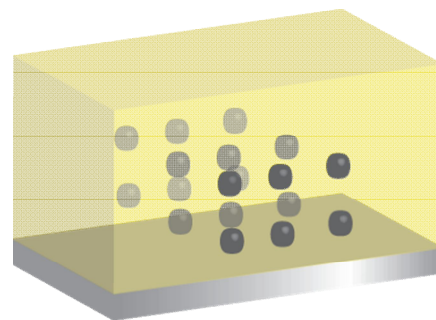
resolution

crystal growth

500 nm



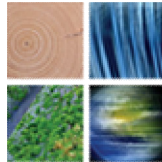
conductivity
device



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Harvard University
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acknowledgements

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- poster @ 6pm

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