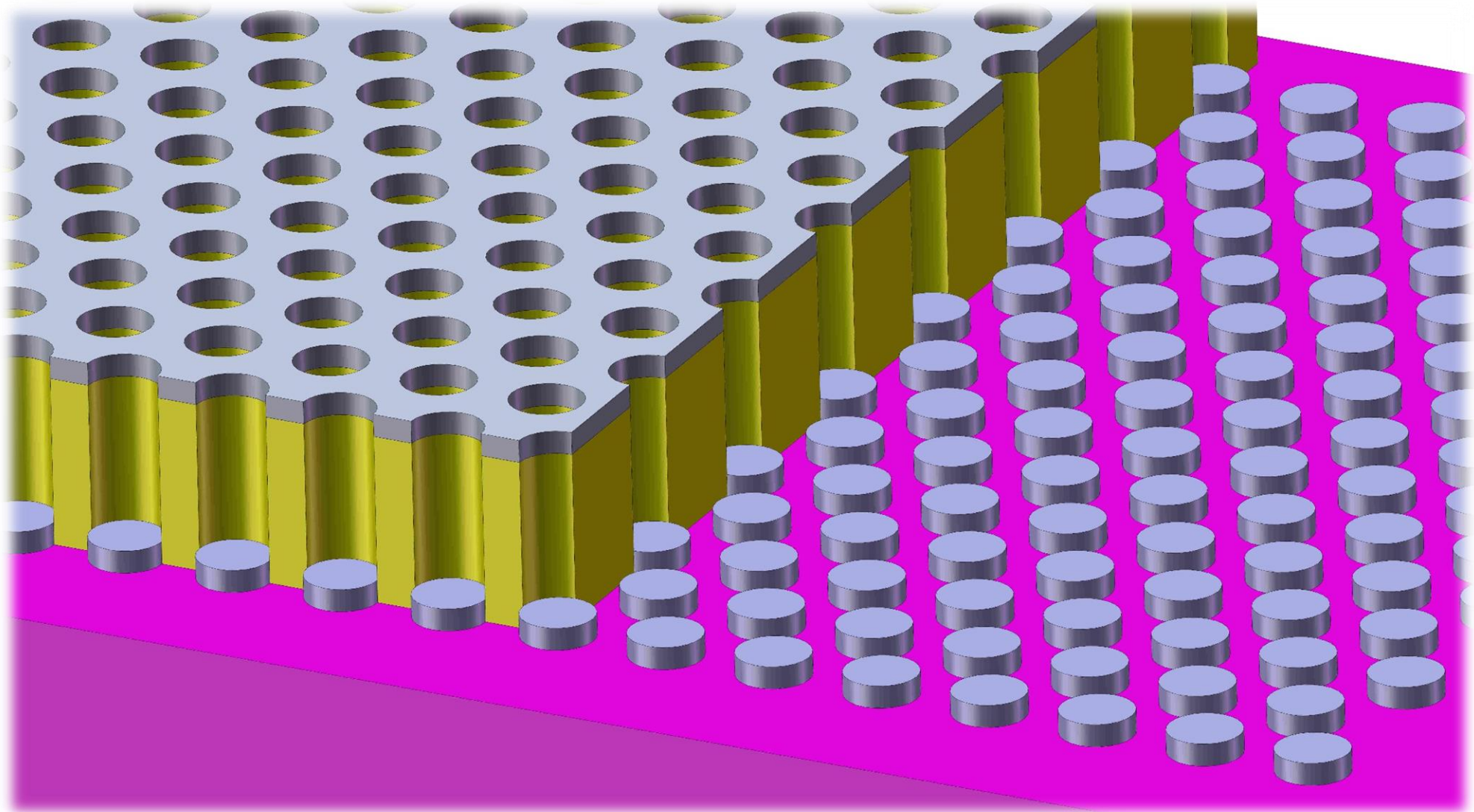


Fabrication of nanoparticle arrays via ultrathin AAO template



Step 1:
Transfer of AAO



Step 2:
Material deposition



Step 3:
Removal of AAO

cleaning and hydrophilic surface treating



substrate

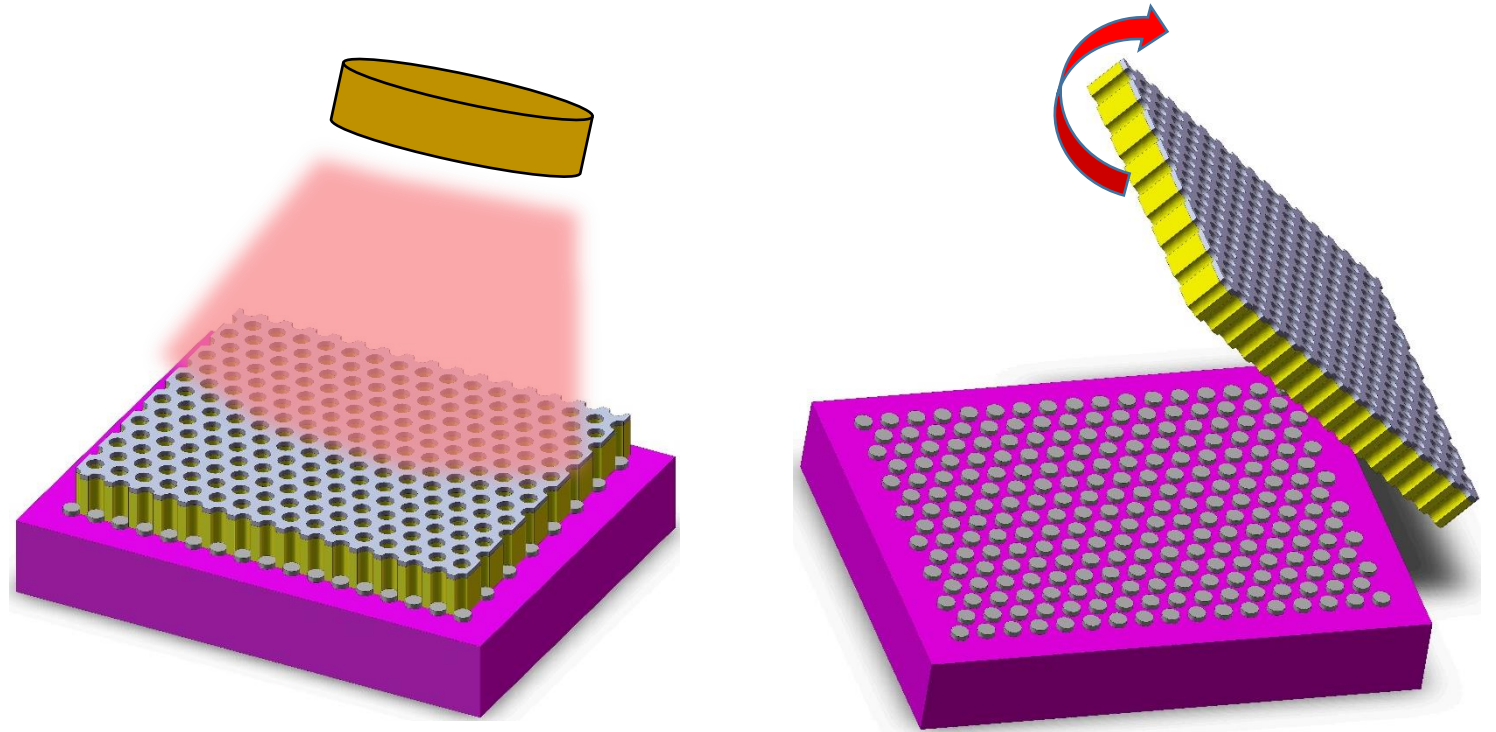


attaching

PMMA

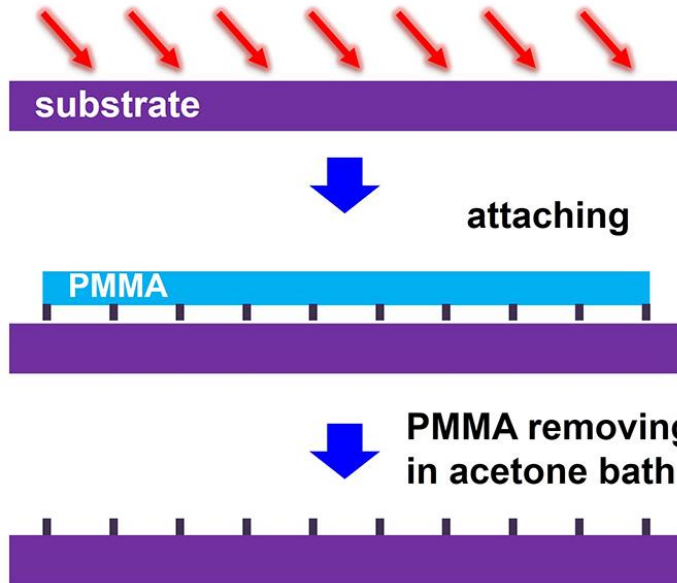


PMMA removing
in acetone bath





cleaning and hydrophilic surface treating

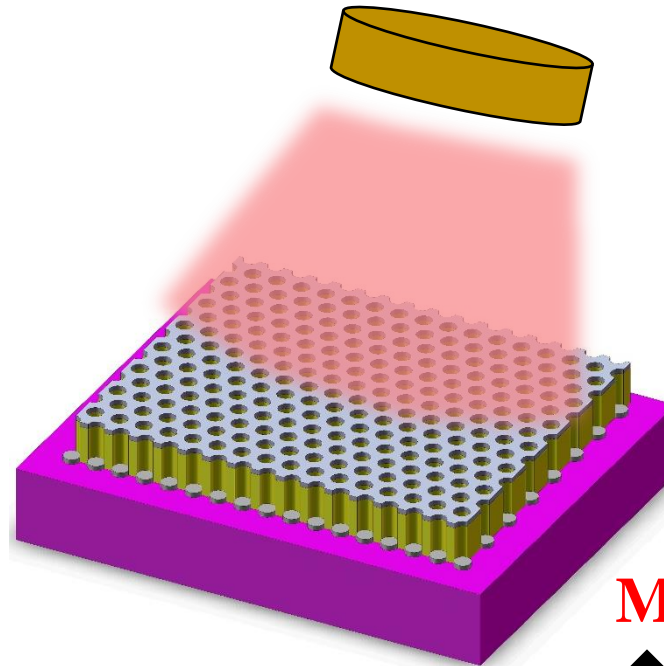


- ◆ **Creating a hydrophilic surface of the substrate is necessary because it enables a good contact between the AAO membrane and substrate.**
- ◆ **PMMA can be completely removed by acetone.**



Typical methods:

- ◆ Electron beam evaporation **(recommended)**
- ◆ Pulsed laser deposition
- ◆ Thermal evaporation
- ◆ Magnetron sputtering **(not recommended)**
- ◆



Materials of the nanoparticles:

- ◆ Metals (Au, Ag, Al, Fe, et al.)
- ◆ Compounds (In_2O_3 , ZnO, et al.)
- ◆ Multilayer particles (Pt/PZT/Pt, $\text{BiFeO}_3/\text{CoFe}_2\text{O}_4/\text{SrRuO}_3$, et al.)
- ◆

Step 1:
Transfer of UTAM



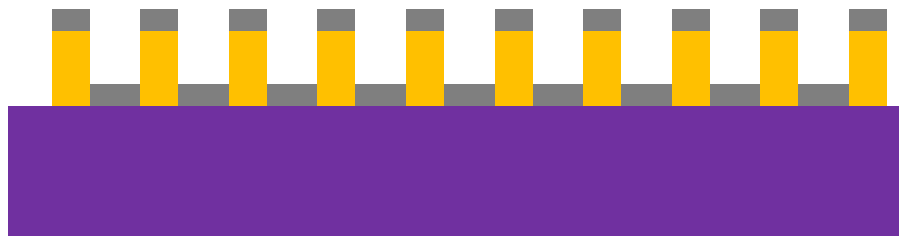
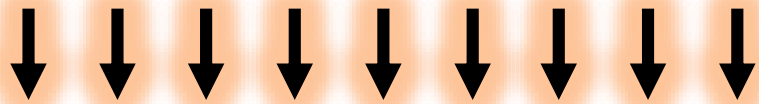
Step 2:
Material deposition



Step 3:
Removal of UTAM

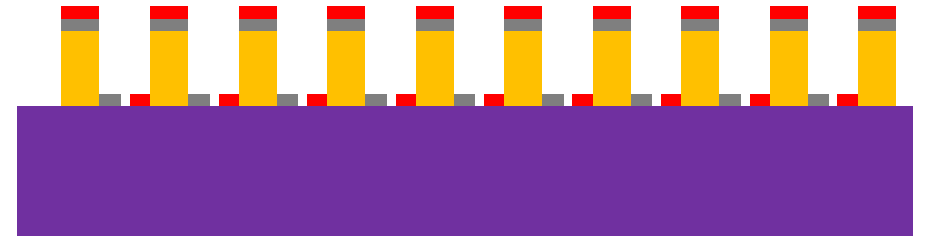
Effects of the incident angle of the material beam

Normal evaporation



(recommended)

Shadowed evaporation



(not recommended!)

Note: Normal evaporation indispensable!

Step 1:
Transfer of UTAM

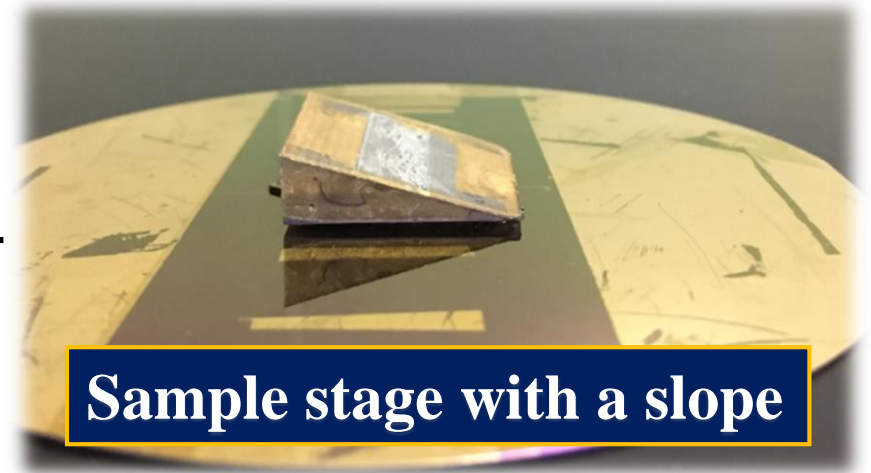
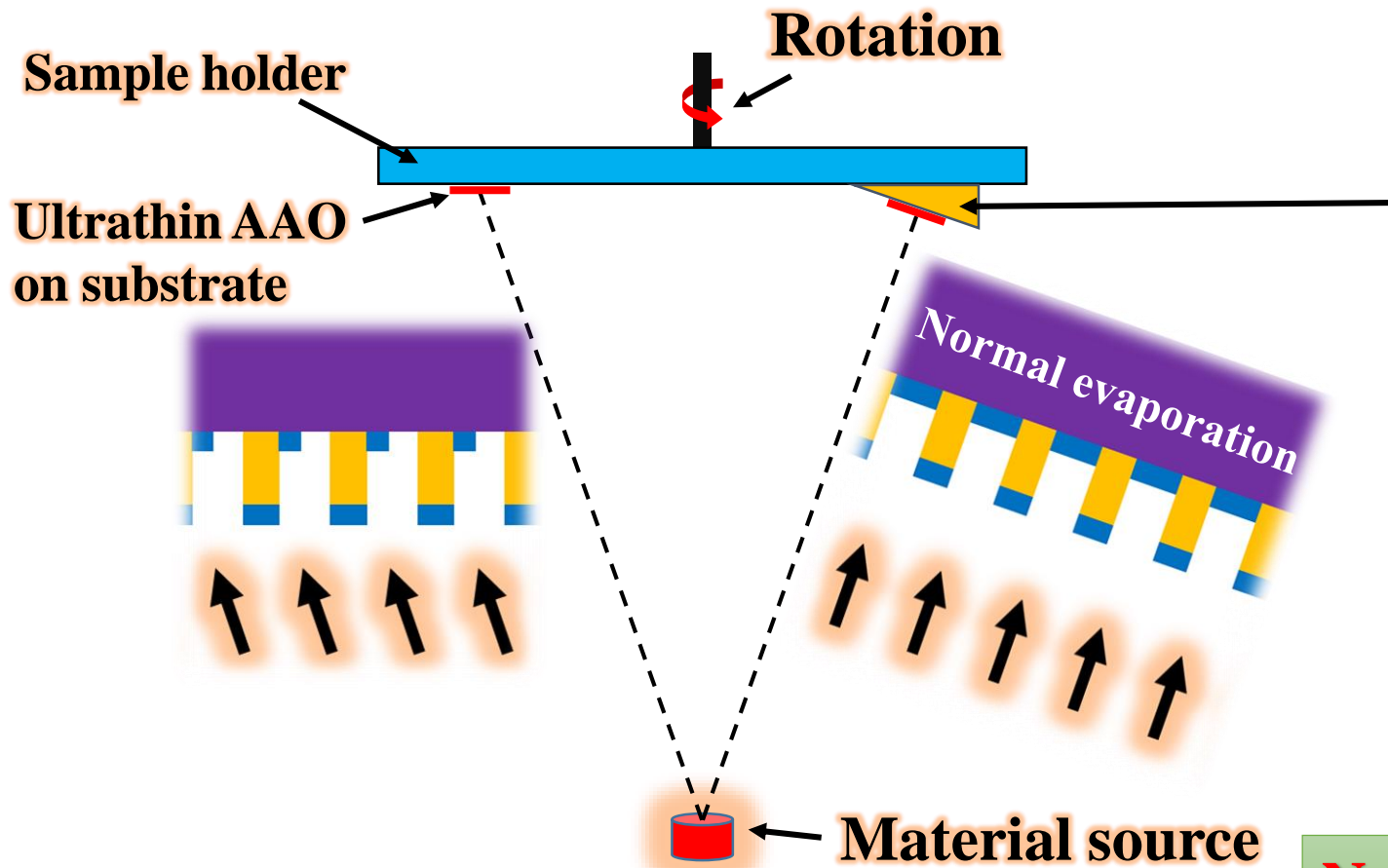


Step 2:
Material deposition



Step 3:
Removal of UTAM

The change of the incident angle of material beam



Tip:

Normal evaporation can be implemented by using a sample stage with a slope.

Note: Normal evaporation indispensable!

Step 1:
Transfer of UTAM

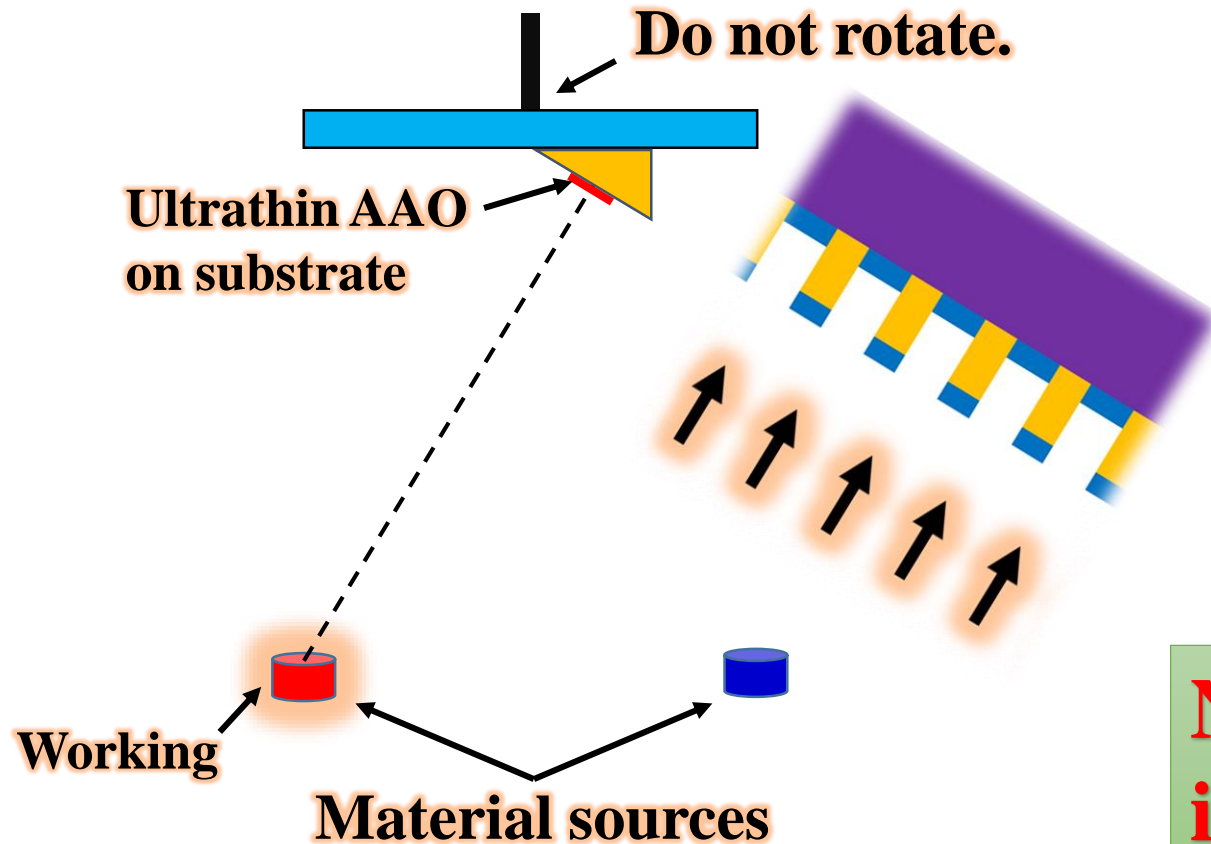


Step 2:
Material deposition



Step 3:
Removal of UTAM

The change of the incident angle of material beam



Tip:

If the rotation axis of the sample holder does not pass the working material source, please do not rotate the holder during deposition.

Note: Normal evaporation indispensable!

Step 1:
Transfer of UTAM



Step 2:
Material deposition

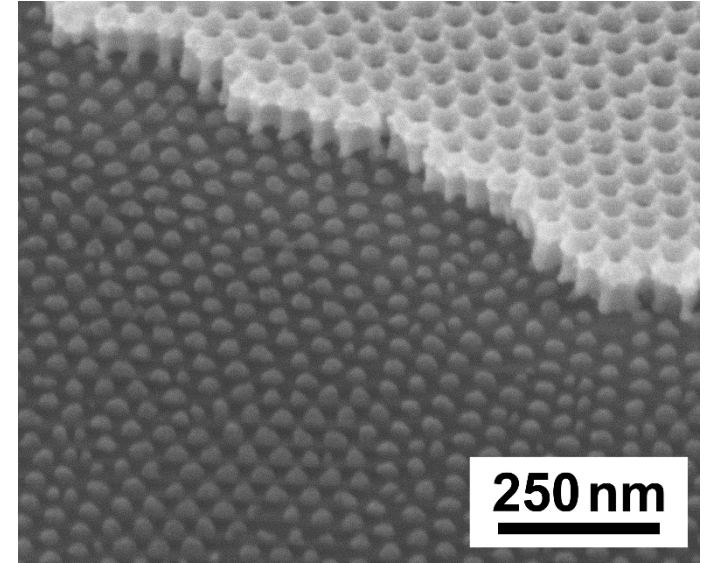
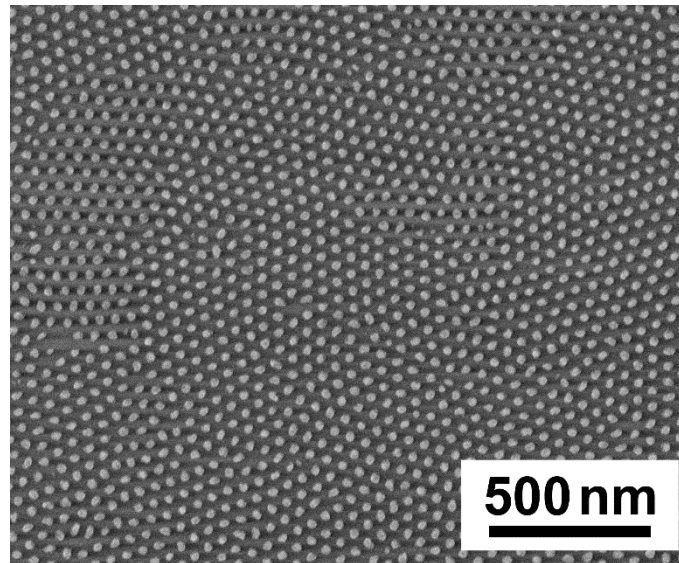
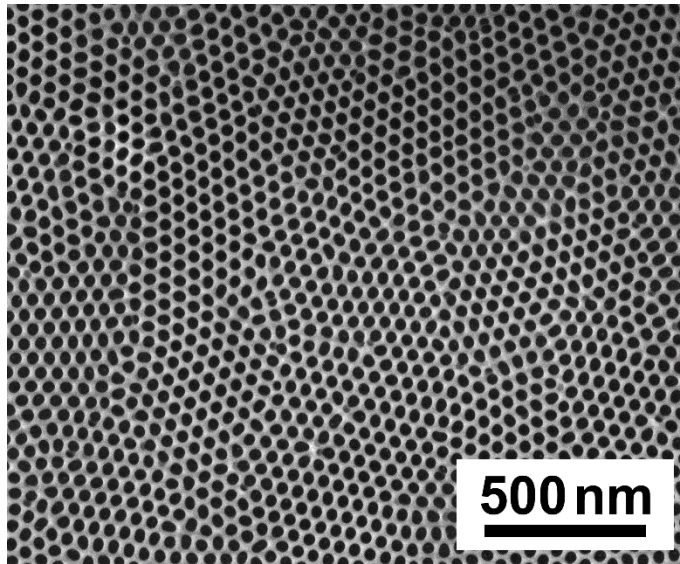


Step 3:
Removal of UTAM

Effects of the incident angle of the material beam

Normal evaporation

Al nanoparticle arrays



Step 1:
Transfer of UTAM

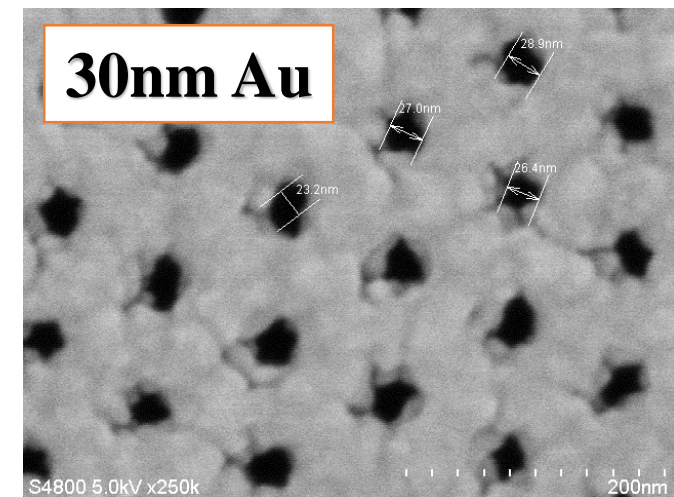
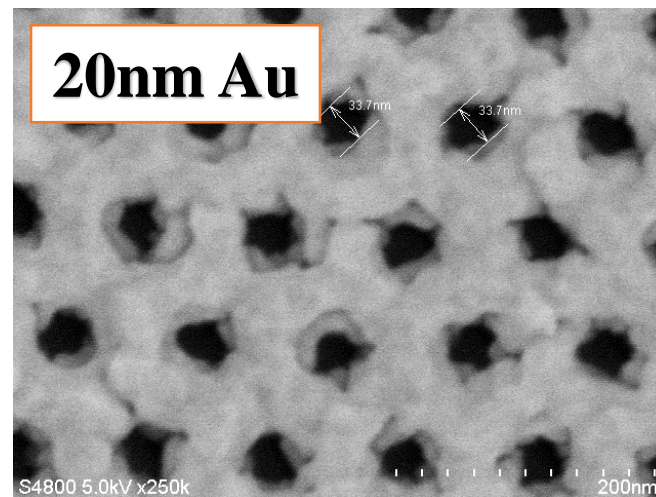
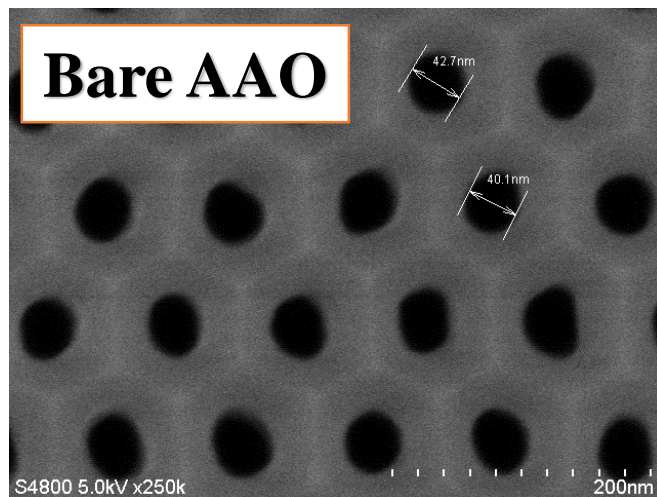
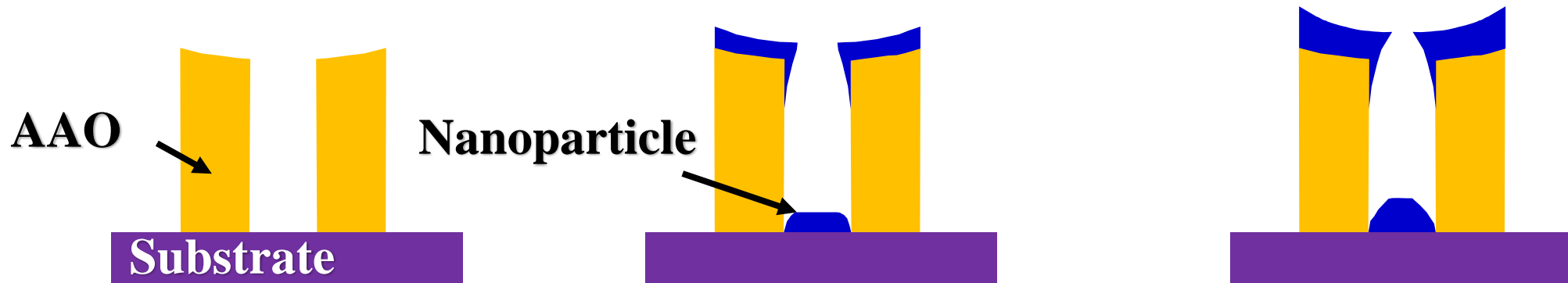


Step 2:
Material deposition



Step 3:
Removal of UTAM

Closure Effect: aperture size shrinks with the deposition progresses



Step 1:
Transfer of UTAM

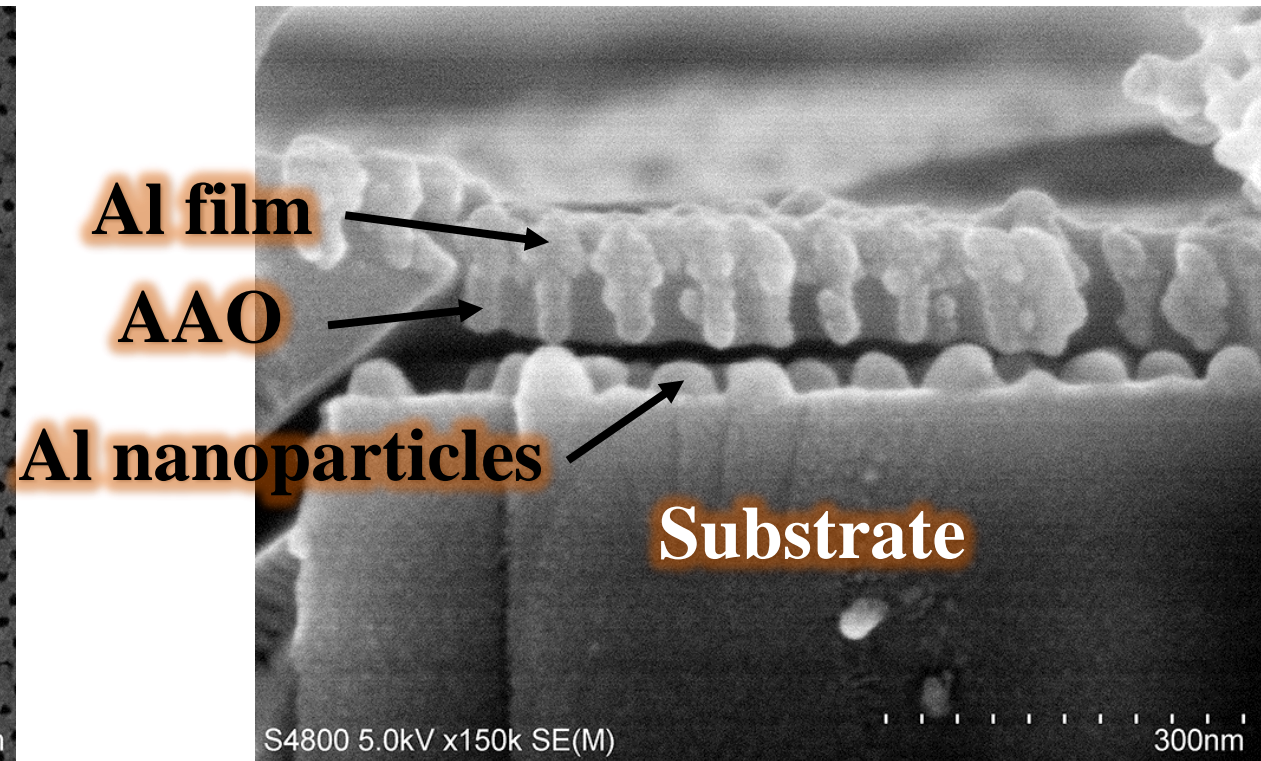
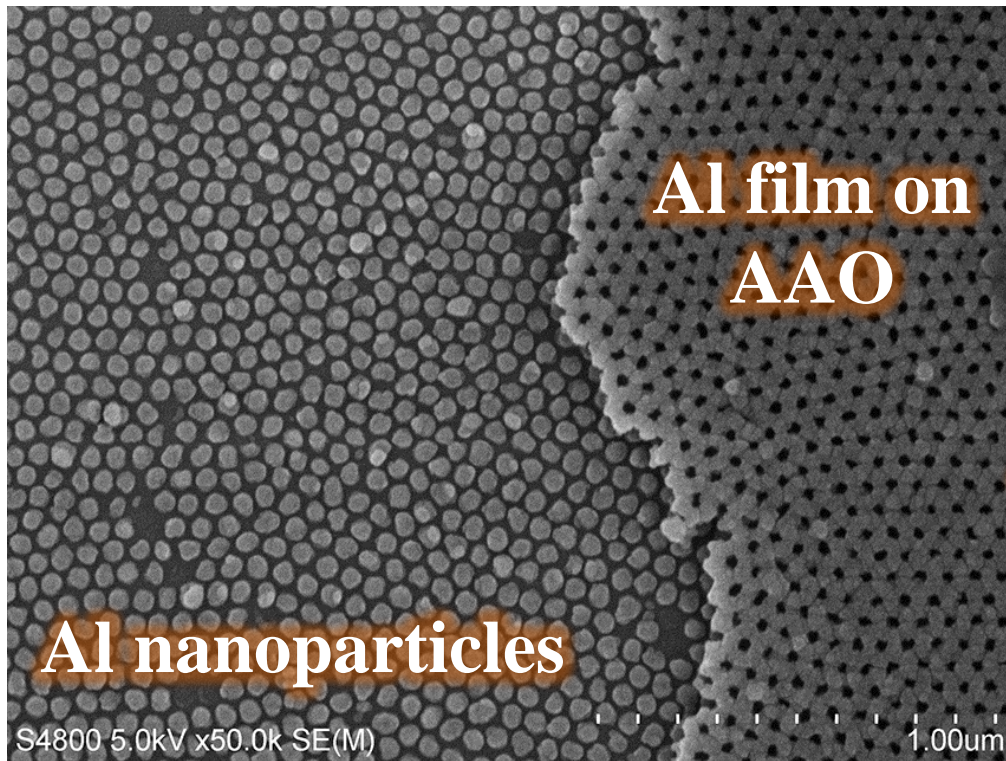


Step 2:
Material deposition



Step 3:
Removal of UTAM

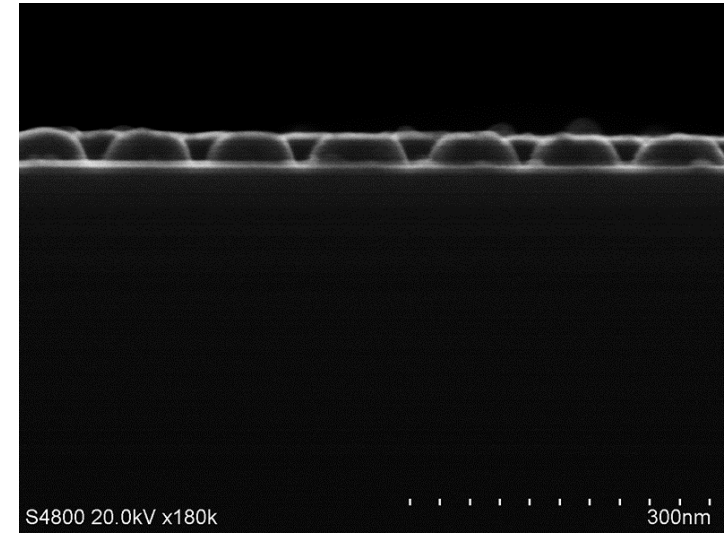
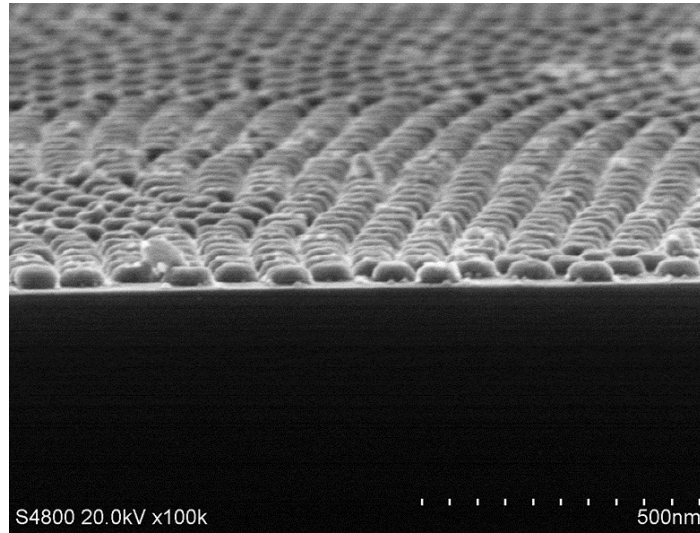
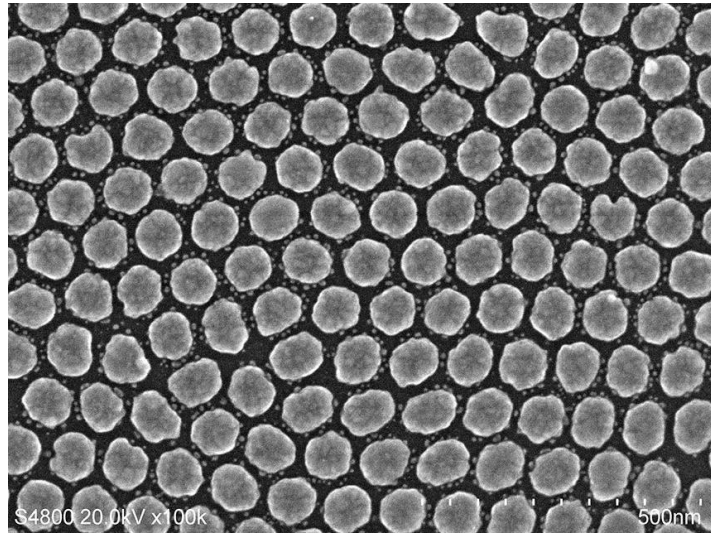
Closure Effect: aperture size shrinks with the deposition progresses





Closure Effect: aperture size shrinks with the deposition progresses

Ag nanoparticles (height=25nm) on Si wafer fabricated via ultrathin AAO template



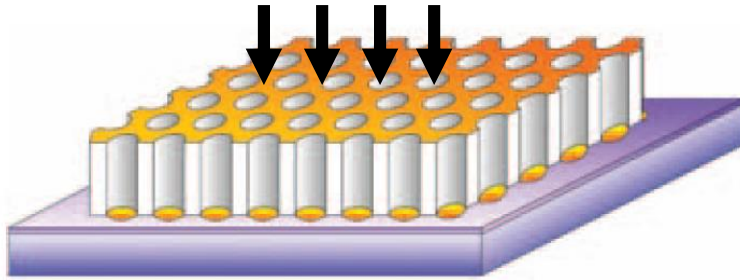


Effect of the aspect ratio (medium deposition thickness)

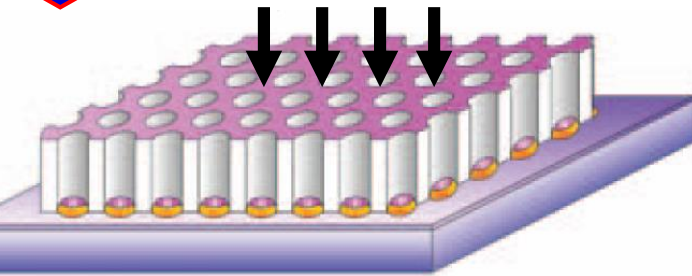


Fabrication of multilayer nanoparticle arrays: Pt/PZT/Pt

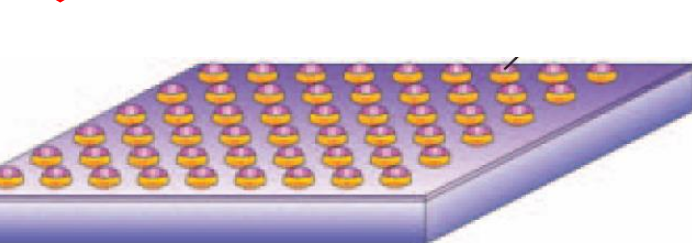
PZT PLD



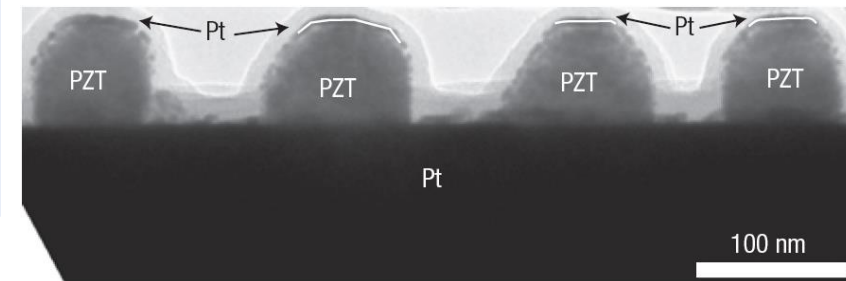
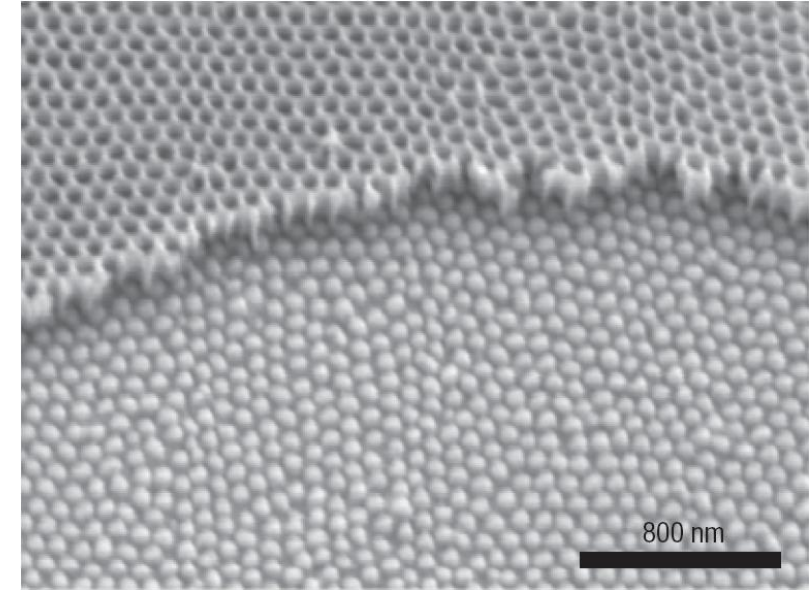
Pt PLD



Lift-off

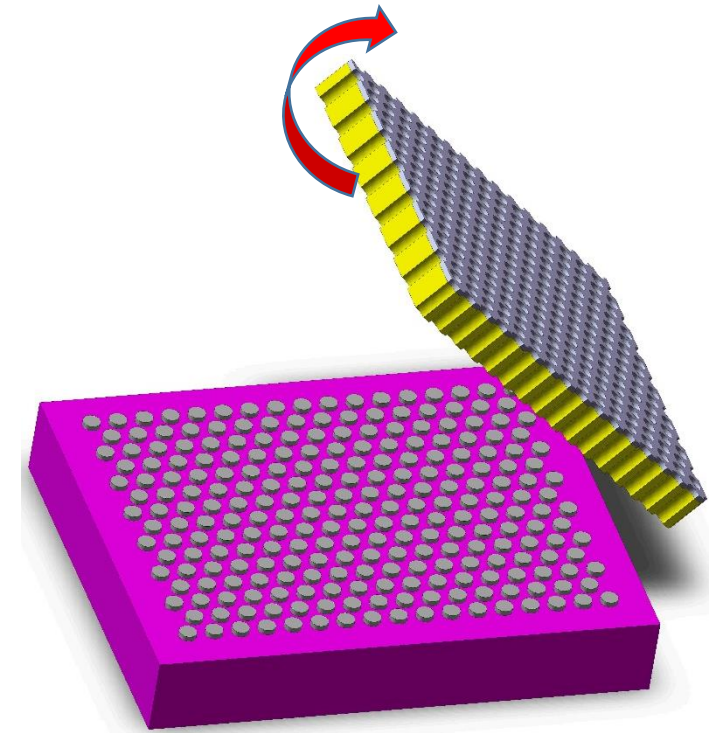


- ◆ Well-ordered large-area 2D arrays of epitaxial $\text{Pb}(\text{Zr}_{0.20}\text{Ti}_{0.80})\text{O}_3$ (PZT) nanoislands were obtained using ultrathin AAO templates as shadow masks.
- ◆ These ferroelectric nanocapacitor arrays that are individually addressable with near Tb inch^{-2} density.



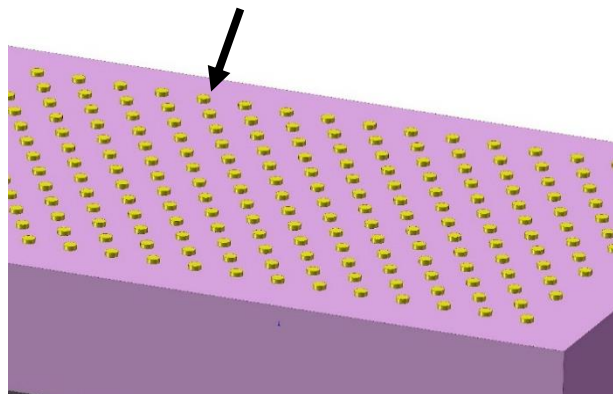


- ◆ Ultrathin AAO template can be removed by 5% phosphate acid at 30°C slowly, or by 5wt.% NaOH at room temperature quickly.
- ◆ Alternatively, the template can be removed by Kapton tape or 3M470 tape. 3M470 tape is highly recommended.

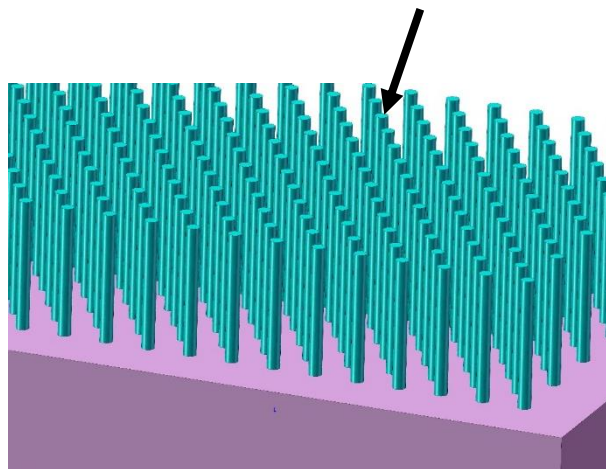


The growth of nanowires using the metal nanoparticle as catalysts.

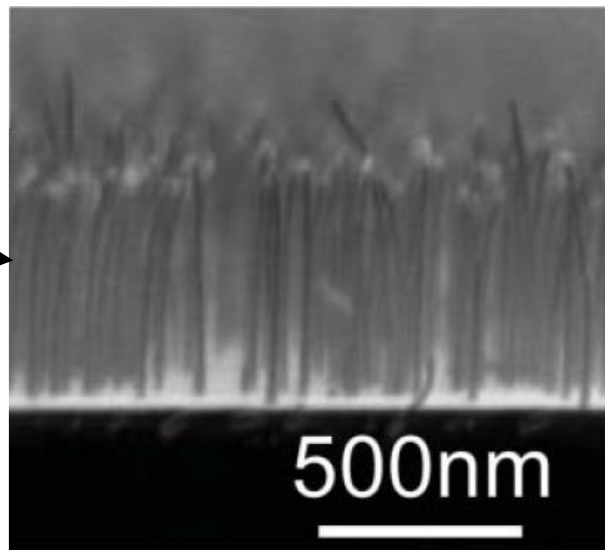
Metal catalyst fabricated by ultrathin AAO template



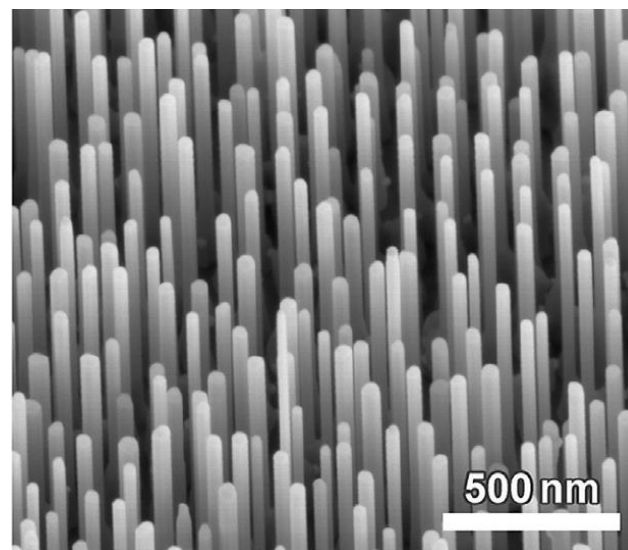
Nanowire arrays via CVD



MgO nanowires on SrTiO₃ (100) substrate

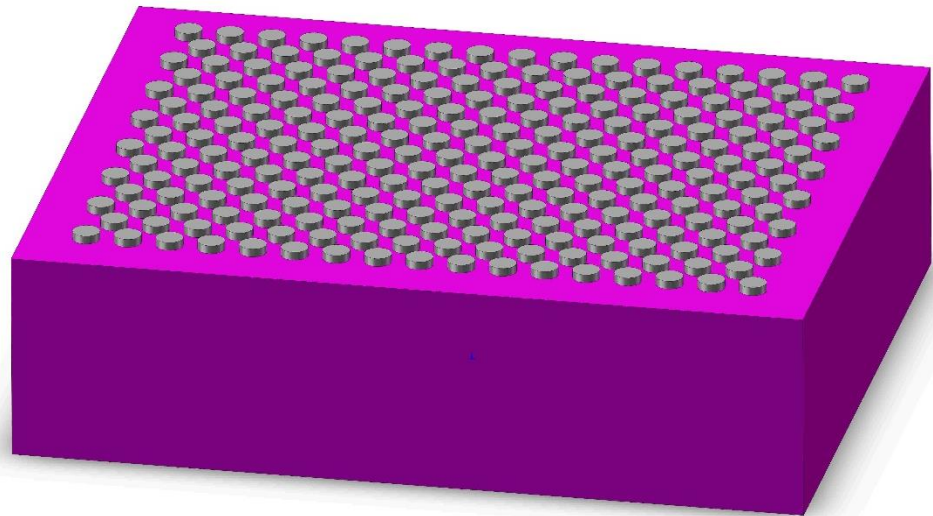


ZnO nanowires on ZnO (0001) single crystal

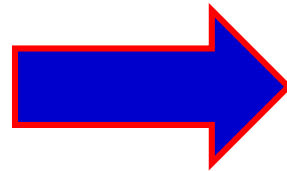


Fabrication of nanopillar array by dry etching

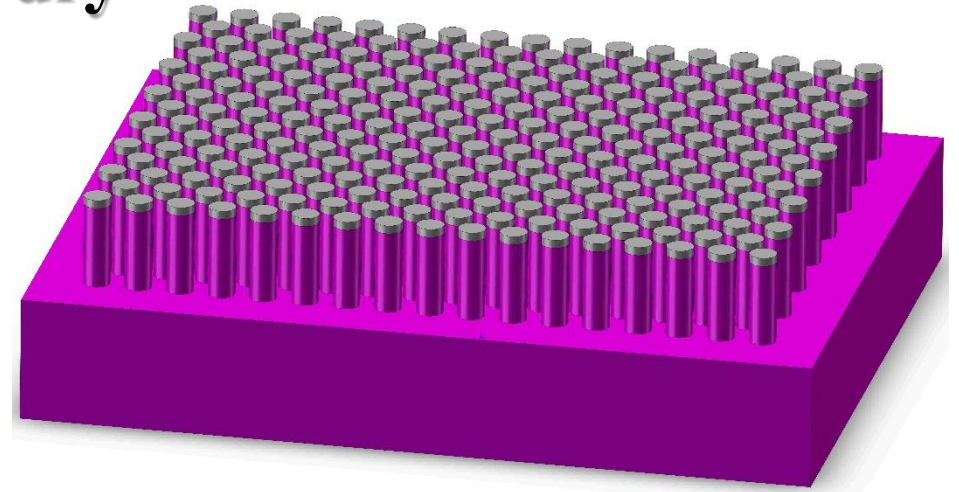
Nanoparticles fabricated by ultrathin AAO template



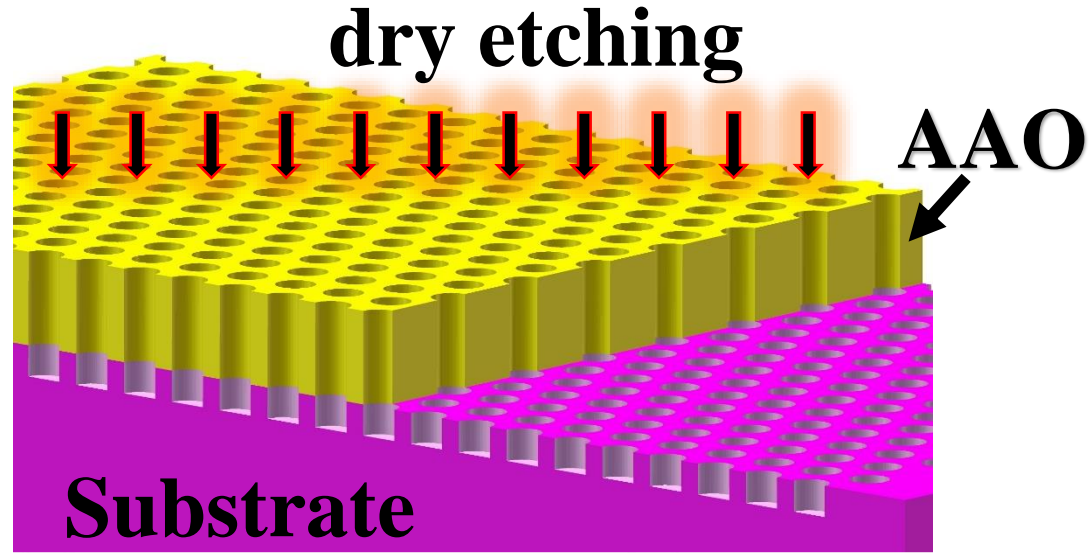
Selective dry etching



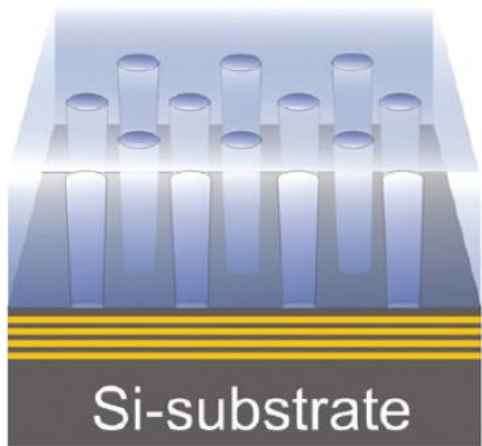
Nanopillar array



Fabrication of nanohole array by dry etching



(a) Patterning the substrate



(b) Reactive ion etching

