

Advanced micro-lithography for Wafer-scale Array Nanostructures for Wide Range Applications: from Hydrophobic to Hydrophilic

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This presentation highlights the wafer-scale fabrication of highly ordered nanostructure arrays using semiconductor-based lithography and sputter deposition techniques. We have successfully produced diverse array architectures, including nanotube array, pillar array, disk array, and mesh, as shown below in Figure 1. Notably, our nanotube array fabrication was recognized with an *American Chemical Society* (ACS) award at Japan Nano Tech 2018 [1] and later featured on the front cover of *Nanoscale* (Royal Society of Chemistry, RSC) in 2025 [2]. The fabrication process involves sputtering metals onto photoresist-patterned contact-hole array templates. By utilizing both metallic and non-metallic materials, we achieve tunable nanostructures with dimensions ranging from several hundred nanometers to 20 micrometers in height and diameter, and geometries such as tall cylinders, dishes, and rhombuses. Additionally, integrating nanomaterials like ZnO nanowires, graphene oxide, or Au nanoparticles enables the formation of hybrid nanostructures. These nanohybrid arrays expand potential applications across various fields with needs for hydrophobic to hydrophilic properties [3,4], including thermal emission, triboelectric nanogeneration [5], SERS-based biosensing, and anti-icing technologies. Additionally, the array structures can be fabricated on flexible polymer, such as PI, for wearable electronic and sensor applications.

References

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- [3] Tunable nanostructured stainless-steel coating for high-selective and high-permeable separation membranes for oil/water emulsions, *npj Clean Water*, 2023, 17.
- [4] Enhanced energy harvesting through lubricant-water interaction on a superoleophobic stainless steel@cellulose ester nanogenerator, *Nano Energy*, 2025, 110958.
- [5] Glassy metallic nanotube arrays based solid-liquid triboelectric nanosensor for wastewater contaminants sensing and its treatment by thermocatalysts, *Advanced Functional Materials*, 2025, e26347.

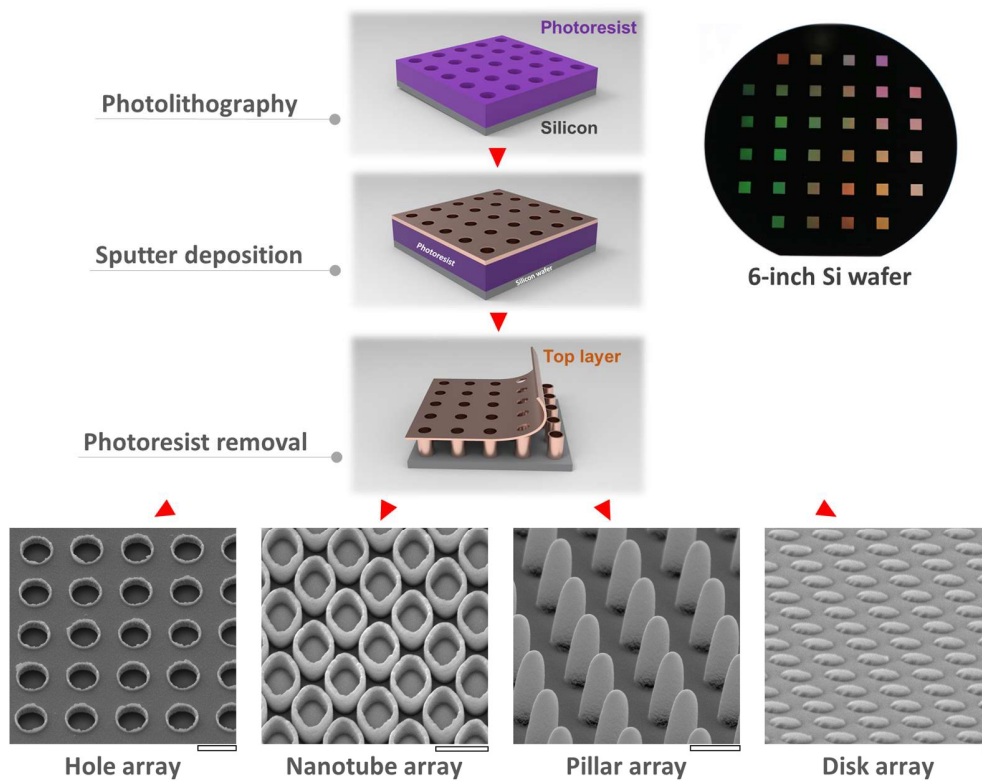


Figure 1: Fabrication steps and SEM images for various array nanostructures: White scale bars at the bottom of each SEM images represent 1 μm .