

Large-Area Well-Ordered Nanodot Array Fabricated with Self-Assembled Nanosphere Template

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Large-area-ordered two dimensional (2D) nanostructures on the surface have extensive applications in photonic devices, biosensors, catalysts and high-density magnetic recording devices. Future success of 2D nanostructures depends on the availability of facile patterning methods that can scale up at low cost. Commonly used patterning techniques such as photolithography, electron beam lithography, and focused ion beam (FIB) lithography have limitations in fabrication of 2D nanostructures. It is very difficult for the photolithography method to generate the features less than 100 nm. The e-beam and FIB techniques are limited by their low throughput in creating large area nanoscale patterns. Patterning with the self-assembled materials as the templates, such as nanosphere lithography pioneered by Deckman and Van Duyne, is an inexpensive, simple, high-throughput alternative routine for creating periodic nanostructures. Self-assembled nanosphere monolayer templates can be fabricated using various techniques, including electrophoresis, electrostatic deposition, spin-coating, and drop-coating of polystyrene (PS) latex nanospheres. However, these processes require hydrophilic substrates and have a difficulty in forming a large-area defect-free PS nanosphere monolayer. In fact, many structural defects such as dislocations, vacancies and randomly occurring disorder can not be avoided during fabricating large-area monolayer templates, which makes it impossible to generate large-area ordered nano-patterns. In the present work, we have introduced a simple method to overcome the above drawbacks and obtained a large-area ($\sim\text{cm}^2$) well-ordered gold nanodot array.

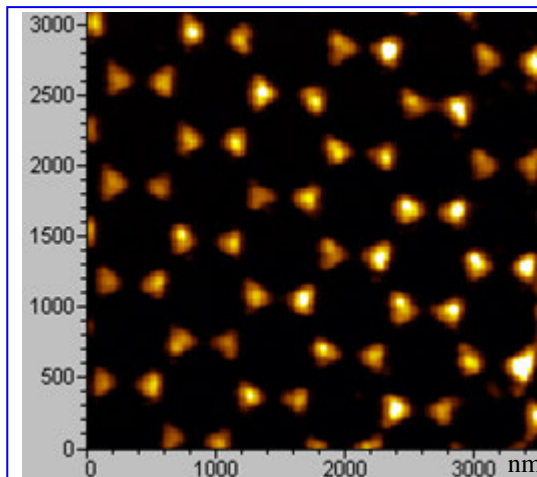


Figure 1 AFM image of gold dot array fabricated with nanosphere lithography

In our approach, dilute PS suspension is dropped on the pretreated glass plate. The PS-covered glass plate is then dipped into water. As a result, the PS spheres are released from the glass plate and formed a self-assembled monolayer on the water surface. Subsequently, the PS monolayer is transferred onto various substrates (Indium Tin Oxide (ITO), gold coated glass, silicon) to form a dense-packed sphere monolayer in a large area ($>1.0 \times 1.0 \text{ cm}^2$). Gold is then deposited on the PS-templated substrate with an evaporator. Finally, the PS template is lifted off, which results in a large-area-ordered gold dot array (as shown in Figure 1). The size of dots and the spacing between dots can be tuned by the post-treatment of the PS template. The nanodot array can be made of a wide range of materials. In short, we have demonstrated a facile approach for quick fabrication of large-area-ordered nanopatterns.

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