Fabrication of Nanosphere Patterns by using Micro-Contact Transfer Printing

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Two-dimensional (2D) ordered sub-microstructured arrays have recently received considerable attention owing to their many applications in electronic devices, biosensors, magnetic materials, phonon diffraction gratings, and photonic crystals. Nanosphere lithography has been studied as a general fabrication method to produce periodic particle arrays with sub-micrometer scale features. Micro-contact transfer printing is based on the direct transfer of a 2D nanosphere monolayer film from a poly(dimethysiloxane) stamp to a substrate [1].

In this paper, a facile method (micro-contact transfer printing) is used to produce 2D nanosphere patterns and arrays. PDMS stamps of various sizes and shapes were fabricated by patterning an original master through a suitable combination of sylgard 184 A and B. The PDMS patterned stamp was then fabricated using the patterned original master [2]. The proposed method of fabricating the close-packed PS nanosphere monolayers is based on the self-assembly of two different sizes of PS nanospheres. The close-packing process requires the PS nanospheres to be able to diffuse freely across the water surface and seek sites with the lowest energy configuration. This floating and scooping technique of the nanosphere coating is a simple but effective method of fabricating 2D PS arrays of nanospheres of various sizes on PDMS stamps, irrespective of the type and surface morphology of the stamp [3]. The transfer procedure of PS nanospheres using micro-contact printing can be used repeatedly (Fig 1). Finally, a PS nanosphere monolayer mask was fabricated. Since the strain temperature of the polystyrene(PS) is approximately 100℃, aligned PS nanospheres were transferred and then heat-treated at 120℃ which resulted in a film-shaped mask by filling the spaces between the spheres. Using this method, various sizes of line and space (L/S) patterns and dot patterns were obtained as can be seen on Fig. 2.

To observe these patterns in detail, AFM images were captured. The grain of the PS nanosphere can be observed at the edge of the patterns as can be seen in Fig. 3. The sizes of the PS nanospheres used in patterning 6μm line and 2μm holes were 600nm and 150nm, respectively.

References

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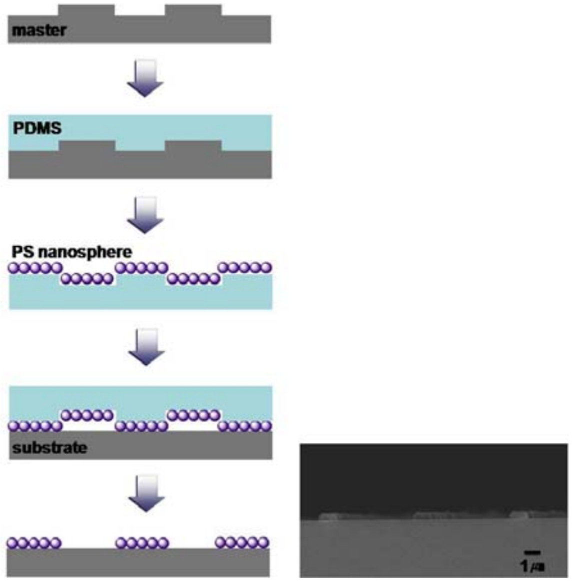

Figure 1. Illustration of PS nanosphere transferring process using the micro-contact transfer printing technique.

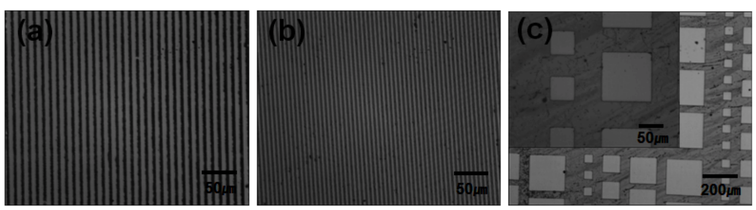

Figure 2. SEM images of the 2D PS nanosphere arrays for (a) 10μm L/S, (b) 6μm L/S, and (c) dot patterns of various sizes

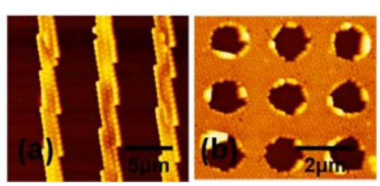

Figure 3. AFM images of the 2D PS nanosphere arrays for (a) 6μm L/S and (b) 2μm contact hole