Nanoscale Patterning using Oblique Angled Deposition Technique in Fabricating Nanostructures with Nanosphere Lithography

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Nanosphere Lithography (NSL) is one of the promising techniques in fabricating large area nanoscale patterns. However, there are limitations in achieving varying nanoscale patterns using NSL and hence, there has been research work on combing the NSL with other micro fabrication techniques. Reactive ion etching combined NSL(1) ,angle-resolved NSL(2) and shadowing effect used NSL(3) have been successfully developed. With current techniques, only one set of nano-structures can be fabricated during material evaporation process. In order to create another set of structures on the same substrate, changes such as varying deposition angle and changing the size of spheres have to be made. This creates more steps and complicates the fabrication process.

In this paper, an elegant way of fabricating more than one set of nanoscale structures is developed by using an oblique angled deposition beam during the thermal evaporation. We fabricated two sets of nanostructures, a triangle and a ring on the same substrate with a single material deposition step. In the conventional NSL, the material deposition beam perpendicular to the NS mask is used to create triangular shaped nanostructure. However, in oblique angled NSL technique, both perpendicular and oblique angled deposition beams are created to make triangle and ring shaped nanostructures respectively. While the former beam is created by fully opening the shutter of the evaporation source, the latter is created by the partial opening. The partial opening results in only the deposition beam slanted at a certain angle being able to reach the substrate. The diagram of conventional and oblique angled NSL and the fabricated structures using both techniques are shown in Fig 1.

Contrary to the most documented works(3) where the slanted depositions are only done by tilting the sample at a certain angle, this concept of creating an oblique angled beam by controlling the amount of shutter opening is new. We will report the formation of various complex nanostructures formed by altering the angle of the shutter opening, the oblique angle of the beam and other factors.

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[1] Cong C, Junus W, Shen Z, Yu T. New Colloidal Lithographic Nanopatterns Fabricated by Combining Pre-Heating and Reactive Ion Etching. *Nanoscale Res Lett* 4: 1324-1328, 2009.

[2] Haynes C, McFarland A, Smith M, Hulteen J, Van Duyne R. Angle-Resolved Nanosphere Lithography: Manipulation of Nanoparticle Size, Shape, and Interparticle Spacing. *The Journal of Physical Chemistry B* 106: 1898-1902, 2002.

[3] Kosiorek A, Kandulski W, Chudzinski P, Kempa K, Giersig M. Shadow Nanosphere Lithography: Simulation and Experiment. *Nano Letters* 4: 1359-1363, 2004.

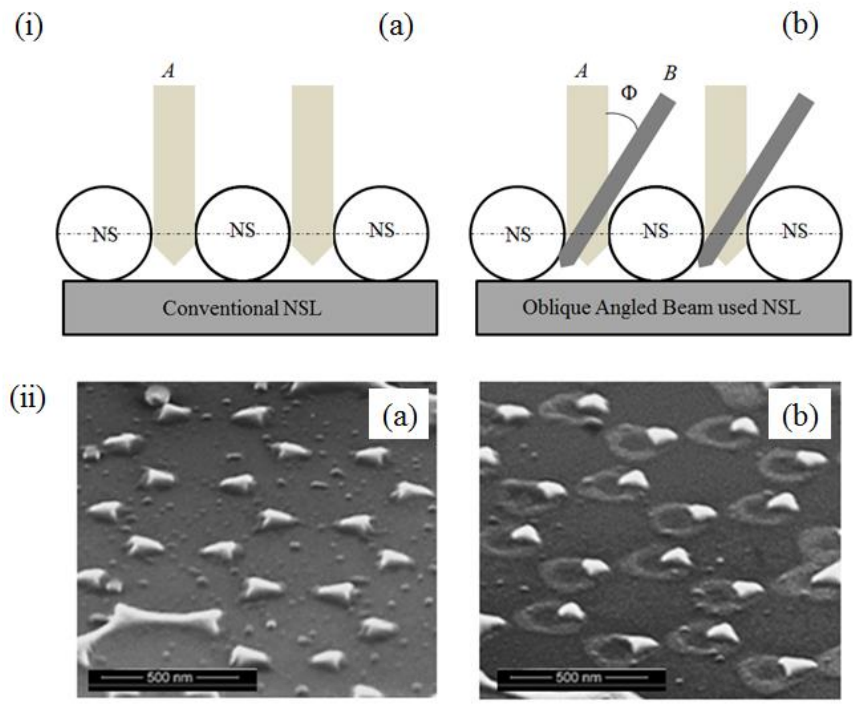

Figure 1: The diagram showing deposition beam direction of Conventional NSL i-(a) and the SEM image showing fabricated triangular structure ii-(a). The diagram showing deposition beam directions of Oblique Angled NSL i-(b) (Beam B – Oblique angled beam and Beam A is normal beam) and the SEM image showing achievable ring combined triangular structure ii-(b).