Nanotech

3D nanostructures fabricated by advanced stencil lithography

Host Professor Pr. B.J. KIM
Keywords Nanofabrication, Nanostencil lithography, artificial smart surfaces

Filiz YESILKOY (EPFL)

Context

Recent efforts in advancing nanofabrication techniques towards control over three dimensions (3D) on the nanoscale have promoted promising new fields of research, such as realization of bio-inspired artificial smart surfaces and optical enantiomer sensing, with a particular focus on the label-free and ultrasensitive detection of biomolecules using circular dichroism spectroscopy. Therefore, there is a pressing need for a high-throughput and large-area 3D nanofabrication method, which can be implemented using standard lithography equipment, and offers material/substrate flexibility and geometric versatility.

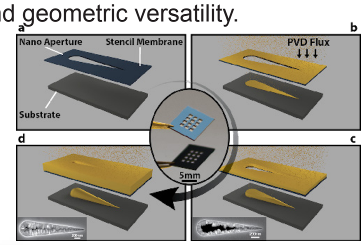

Fig. 1. Stencil lithography clogging effect for 3D nanofabrication

Objective&Methods

This work [1] focuses on a novel fabrication method for 3D metal nanostructures using high-throughput nanostencil lithography. Aperture clogging, which occurs on the stencil membranes during physical vapor deposition, is leveraged to create complex topographies on the nanoscale as seen in Fig. 1. The precision of the 3D nanofabrication method is studied in terms of geometric parameters and material types. The versatility of the technique is demonstrated by various symmetric and chiral patterns made of Al and Au.

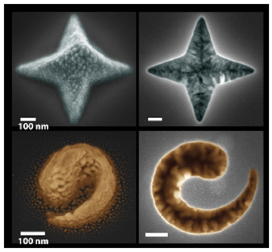

Fig. 2. 3D nanostructures in Al (four-pointed star) and Au (snail shape).

Results

We developed a novel use of stencil lithography to extend its applications to the height profile regulation that allows for the fabrication of 3D nanostructures with inhomogeneous thickness profiles. SEM and AFM acquired visual and topographical data is used to characterize the lithographic capabilities of our method. Our analysis of the AFM data showed no significant influence of the aperture dimension or geometry on the clogging rate; however, data revealed a strong material dependence. Moreover, we presented various patterns both with straight—four-pointed star—and curved—snail—geometric elements at different dimension scales, both with micron and submicron features, to illustrate the versatility and scalability of this approach, while discussing the resolution limiting aspects such as blurring and grain size dependence (see Fig. 2).

References

[1] F. Yesilkoy, et al., Nanoscale 8, 4945–4950, 2016.