Science Advances
AAAS

advances.sciencemag.org/cgi/content/full/2/5/e1600084/DC1

Supplementary Materials for

Biomimetic gyroid nanostructures exceeding their natural origins

Zongsong Gan, Mark D. Turner, Min Gu

Published 13 May 2016, *Sci. Adv.* **2**, e1600084 (2016)
DOI: 10.1126/sciadv.1600084

The PDF file includes:

- S1. When optical single-beam lithography is used to fabricate a smaller-sized feature, a lower fabrication laser exposure dose is normally used.
- S2. AFM characterization of mechanical property.
- S3. White light reflection microscopy images of artificial gyroid structures.
- fig. S1. Comparison of changes in polymerization degree between optical single-beam lithography and optical two-beam lithography to reduce the fabricated feature size.
- fig. S2. AFM measurement of mechanical strength.
- fig. S3. White light reflection microscopy images of artificial gyroid structures.

S1. When optical single-beam lithography is used to fabricate a smaller sized feature, normally less fabrication laser exposure dose is used.

This process can reduce the conversion rate of monomer to polymer (which is called polymerization degree). Figure S1A shows that when the linewidth goes from 150 nm (a) to 90 nm (b), the polymerization rate at the centre position (x=0 μm) decreased more than 20%. However, when optical two-beam lithography is used to decrease the linwidth from 150 nm to 90 nm, the polymerization rate at the centre position (x=0 μm) can be kept unchanged (fig. S1B). When the steepness of the side slope is considered for the polymerization degree curve, it undoubtedly becomes higher when the inhibition beam is used. Thus, the polymerization degree averaged over its feature size can be higher when compared d with c in fig. S1B. There are many factors which can finally determine the mechanical strength property of the fabricated feature. These include the fluctuation of the endorsed energy, the shape of the polymerization degree curve and conditions of washing-out process. Compared with washing-out conditions, the influence on the mechanical strength is more sensitive for the shape of the polymerization degree curve as it can affect the washing-out process. Thus a slight change in the polymerization degree curve may greatly affect the fabricated feature when its maximum value approaches the threshold.

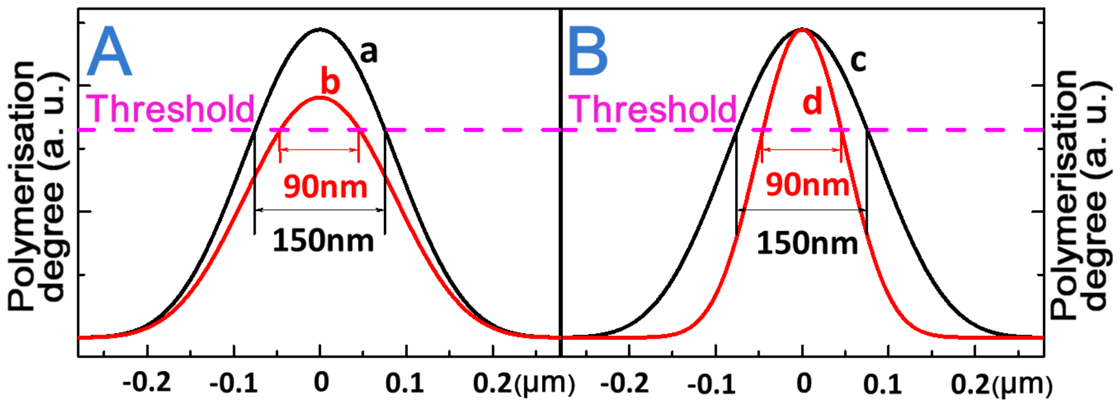

fig. S1. The comparison of change in polymerisation degree for optical single and two beam lithography to reduce the fabricated feature size. (A) Conventional optical single-beam lithography. (B) Optical single-beam lithography.

S2. AFM characterization of the mechanical property.

Suspended lines are fabricated with a length of 1000 nm. The lines are suspended by blocks fabricated with the inhibition beam off and larger fabrication beam exposure dose. After fabrication and washing out, the sample was loaded on the atomic force microscope (AFM) (NT-MDT). The schematic of the measurement is shown in fig. S2A.

The non-contact mode of AFM was used to get the topography images of the sample and this helps to establish the region of interest. After that, the contact mode of the AFM was used to get the "DFL signal"-displacement curve (both approach and withdrawal curves). A typical "DFL signal"-displacement curve was shown in fig. S2B.

When the AFM tip physically contacts the suspended line, it causes a deformation. If the measured sample can be considered as ideally elastic materials, the amount of deformation under different amount of applied tip force shows the elastic-plastic behavior of the sample. Thus the mechanical behavior of the sample can be investigated by this method. In the contact mode the DFL signal is used as a parameter characterizing the interaction force between the tip and the sample. There is a linear relationship between the DFL value and the force (see the NT-MDT official website: http://www.ntmdt.com/spm-principles/view/afm-constant-force-mode). Thus at the contact region, the parameter of $|d(DFL)/d(Displacement)|$ qualitatively reflects the elastic Young's modulus of the sample.

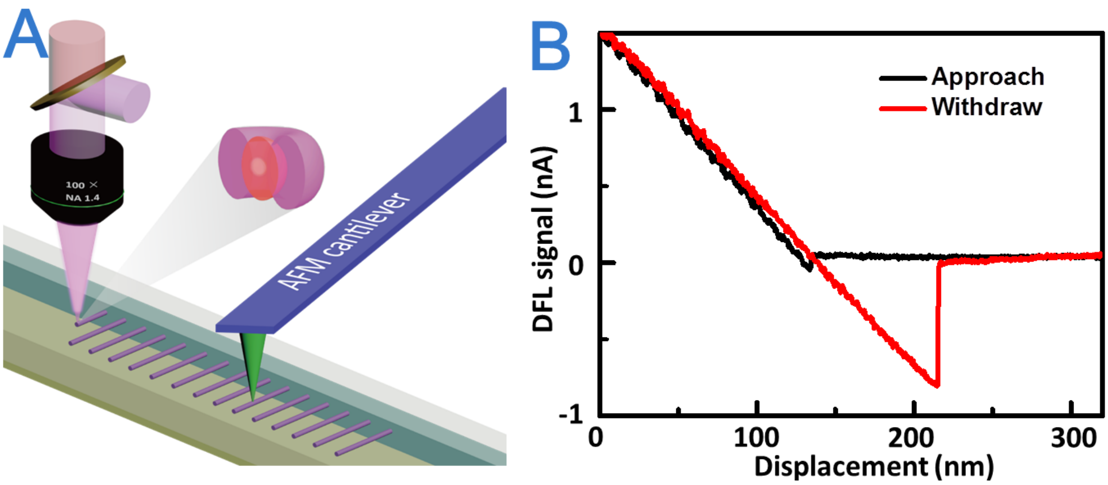

fig. S2. AFM measurement of mechanical strength. (**A**) Schematic of the AFM measurement. (**B**) A typical force-displacement curve measured for the characterization of the mechanical property.

In this work, we are not interested in the absolute value of the elastic Young's modulus of the sample. Because of this, $|d(DFL)/d(Displacement)|$is used to compare the elastic Young's modulus of the sample fabricated with optical two-beam lithography for the inhibition beam on and off. As the AFM measurement is a local measurement with a contact area of $2\pi R^2$ which is much smaller than the surface area of the measured sample, samples measured to have the same $|d(DFL)/d(Displacement)|$ value can be regarded having the same mechanical strength.

S3. White light reflection microscope images of artificial gyroid structures.

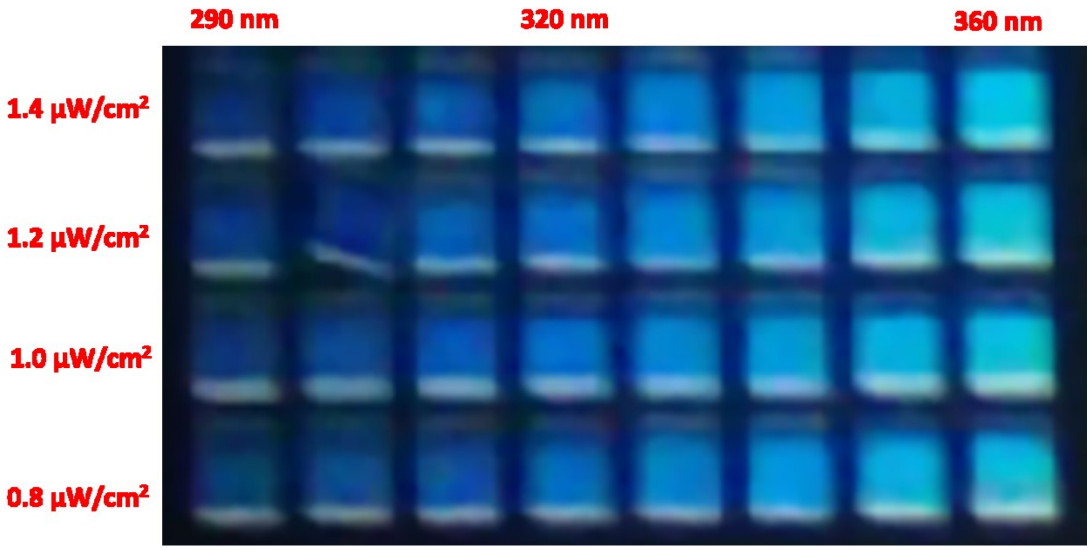

fig. S3. White light reflection microscope images of artificial gyroid structures. The lattice constants change from 290 nm to 360 nm (10 nm each step from left to right). The gyroid structures in each column of this figure are fabricated with the same geometrical conditions but with different inhibition beam intensity (The one with a lattice constant of 300 nm and an inhibition beam intensity of 1.2 μm/cm^2 looks different with the others. This is because this structure does not connect well with the supporting cover glass).