Fabrication of low-cost and high aspect ratio nanowires and 2D nanostructures by soft lithography for nanophotonic devices

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Abstract

High aspect ratio nanostructures are needed for relevant photonic applications like light harvesting, light generation and amplification and optical sensing. High quality nanoimprint lithography (NIL) can be carried out using a low cost version called soft lithography. This method was introduced as a low-cost alternative to conventional lithography, and has been shown to be a powerful method to generate reproducible nanopatterns in wide areas (in the order of square cm) using elastomeric polymers like polydimethylsiloxane (PDMS) or others [1]. However, due to the low level of stiffness of PDMS, only limited aspect ratios are achievable. In this work, high aspect ratio silicon nanowires and nanostructures have been achieved by the combination of soft lithography and the careful optimization of the reactive ion etching (RIE) process used to transfer the nanopatterns to silicon. Using this procedure we have obtained lineal nanopatterns in areas in the order of square cm with high aspect ratios around 1.2 and 1.6, which are among the best found in the literature. Furthermore, we have achieved this results using low-cost commercial DVD and Blu-Ray as masters to obtain the PDMS stamp (Figure 1a)..We have also fabricated 2D nanostructures (Figure 1b) and achieved high aspect ratios of 5.4. The reflectivity of these samples, which is critical for potential photonic applications, was measured. Figure 1(c) shows the reflectivity of silicon nanowires fabricated with different aspect ratio. Finally, the fabricated nanowires have been used for different applications like the enhanced generation of solar thermal energy [2] or new nanophotonic optical sensors [3].

References

[1] Y. Xia, G.M. Whitesides, Soft lithography, Annual review of materials science, 28 (1998) 153-184.

[2] S. Núñez-Sánchez, E. Baquedano-Peralvarez, J. Pugh, P. A. Postigo, N.A. Fox and M. J. Cryan, ECIO2016.

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Figures

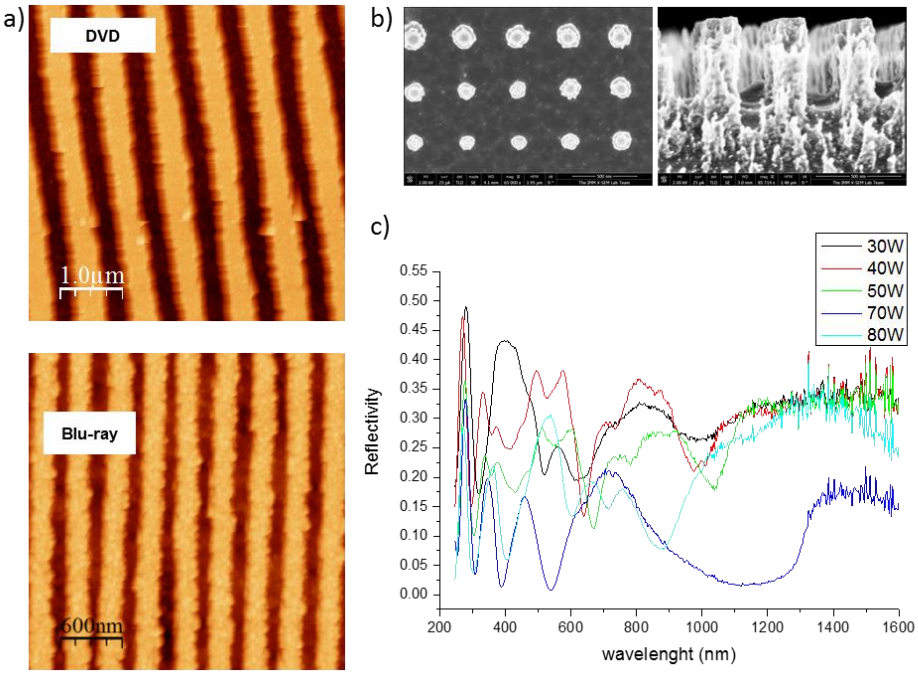

Figure 1. a) AFM images of patterns resultant for DVD and Blu-ray on silicon. b) SEM images of patter 2D on silicon. c) Reflectivity for silicon nanowires with different aspect ratio obtained by different RIE etching powers.