Plasmonic nanostructures based on DNA origami silhouettes

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The field of plasmonic nanostructures has grown rapidly due to their unique optical properties and field enhancement. However, due to limitations of the conventional nanofabrication methods nanostructures with plasmonic activity in visible range, are hard to fabricate. Yet, DNA self-assembly provides a precise and programmable way to form nano-scale structures [1]. We demonstrate a novel method, which combines the DNA origami and conventional nanofabrication processes for fabrication of high quality sub-100-nm plasmonic nanostructures with desired shape and operation in visible range. The method employs DNA origami silhouettes in a silicon dioxide layer, formed by DNA selective chemical vapor deposition process [2] followed by several nanofabrication processes as shown in figure below [3]. The resulting structures have a figure size around 20 nm which is already comparable to the e-beam lithography.

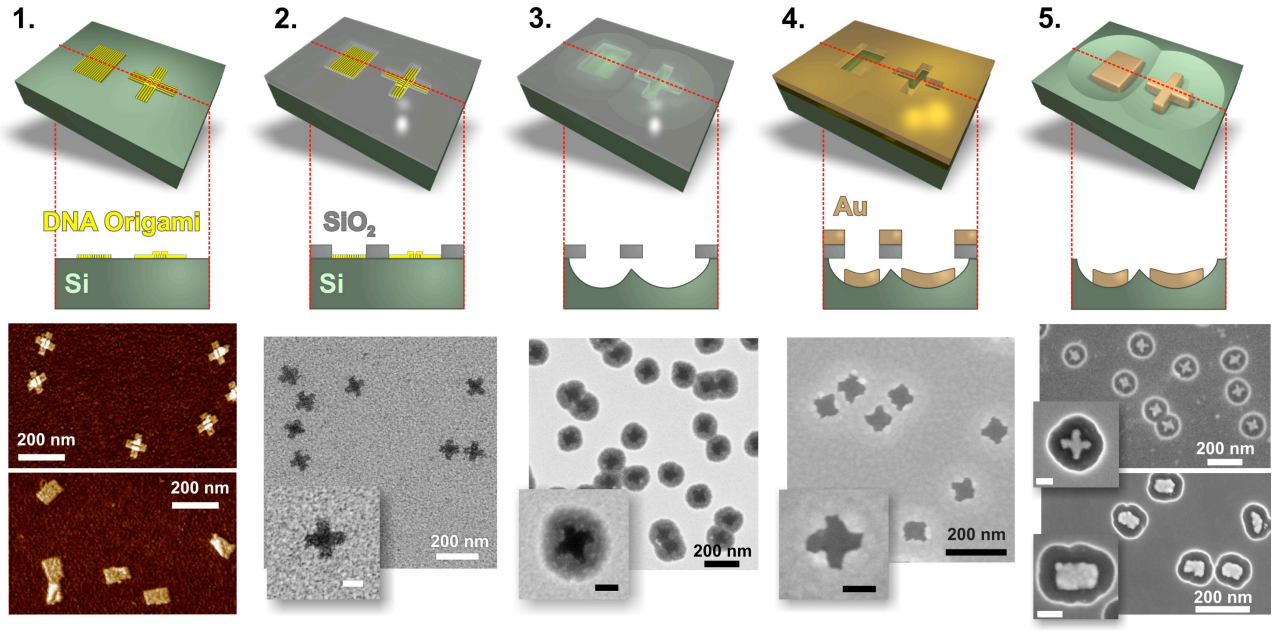

Fig. 1: Fabrication of gold nanostructures [3]. ***Step 1:*** DNA origami structures are deposited onto the silicon (Si) substrate. ***Step 2:*** Silicon dioxide (SiO_2) layer is grown in a chemical vapor deposition (CVD) process on Si. The oxide layer grows selectively, and thus "DNA origami silhouettes" are created [2]. ***Step 3:*** The "silhouettes" are used as openings in etching of the silicon underneath the SiO_2 layer. The reactive ion etched wells in Si are clearly visible beneath the silhouettes. ***Step 4:*** Gold is deposited onto the chip using an electron beam evaporator. ***Step 5:*** The SiO_2 layer (with the metal on top) is removed in a HF:HCl –lift-off procedure. This leaves the DNA origami-shaped gold nanostructures on the silicon chip. The scale bars in the insets are 50 nm.

[1] N. C. Seeman, Nature 421 (2003) 427-431; P.W.K. Rothemund, Nature 440, 297 (2006).
[2] S.P. Surwade, F. Zhou, B. Wei, W. Sun, A. Powell, C. O'Donnell, P. Yin, H.T. Liu, J. Am. Chem. Soc. 135, 6778 (2013).
[3] B. Shen, V. Linko, K. Tapio, M.A. Kostiainen, J.J. Toppari, Nanoscale 7, 11267 (2015).