Research data for the Nature Nanotechnology paper

# Reconfigurable nanomechanical photonic metamaterials

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Video file: FIB_Fabrication.mov
Title: **Focused ion beam fabrication of an array of metamaterial samples**
Description: Prototyping membrane reconfigurable metamaterial. Focused ion beam (FIB) milling is used to pattern a 4 x 4 array of metamaterial samples on pre-fabricated gold patches supported by a silicon nitride membrane of 50 nm thickness. Milling includes patterning of the gold film and cutting through the silicon nitride membrane, where appropriate. The video, which has been recorded by scanning electron microscopy (SEM), is compressed to a few seconds while the total FIB milling time is about 22 minutes. Video courtesy of Jun-Yu Ou.

Video file: Actuating_Chevron_Metamaterial.mov
Title: **Actuating nanomembrane chevron metamaterial**
Description: Chevron nanowire array fabricated on a silicon nitride nanomembrane. To show reconfiguration of the metamaterial every second chevron nanowire is heated by electrical current running through the nanowire and heated nanowires bend due to differential thermal expansion of the gold and silicon nitride layers that make up the nanowires. The SEM video shows the central part of the array with alternating nanowires moving from the plane of the array. Actuation of the metamaterial is seen at a viewing angle of 30° while the total applied current is increased from zero to +7 mA and then reduced via zero to -7 mA and finally returned to zero. The same structure can also be driven by the magnetic Lorentz force acting on current-carrying nanowires when an external magnetic field that is oriented perpendicular to the current flow is applied. Note that SEM imaging of nanowire actuation driven by the Lorentz force is impossible, as the required static magnetic field would interfere with the scanning electron microscope. Video courtesy of João P. Valente.

Video file: Electrostatic_Metamaterial_Switch.mov
Title: **Switching nanomembrane electro-optical metamaterial with the Coulomb force**
Description: Irreversible switching transition of an electrostatically reconfigurable plasmonic metamaterial fabricated on a silicon nitride nanomembrane. When the driving voltage is less than the switching threshold voltage of about 3 V, the structure can be modulated in a reversible fashion. The SEM video shows that when the applied voltage increases above the threshold voltage, the plasmonic nanostructure switches irreversibly into a string-pair configuration, resulting in a dramatic change of the metamaterial's optical properties. The image drift is caused by the applied voltage. Video courtesy of Jun-Yu Ou.

Video file: Random_Access_Metamaterial.mov
Title: **Actuating individual wires in randomly reconfigurable nanomembrane metamaterial**
Description: Random access reconfigurable metamaterial. An array of nanowires on a silicon nitride nanomembrane allows independent electrical actuation of each nanowire of the array. The SEM video shows how electrical current supplied to individual nanowires by a computer-controlled multi-channel digital-to-analog converter actuates the nanostructure. In this way the optical response of the metamaterial can be controlled in one dimension with 600 nm resolution (period of the array). In the SEM video the nanowires are driven by differential thermal expansion in response to resistive heating. Actuation with the Lorentz force is also possible but cannot be imaged using SEM due to the required magnetic field. Video courtesy of Pablo Cencillo-Abad.