High performance metasurface holography

With the support by the National Natural Science Foundation of China, Professor Zhang Shuang's laboratory at the School of Physics and Astronomy, University of Birmingham, UK, and Professor Zheng Guoxing's laboratory at the School of Electronic Information, Wuhan University, reported a high performance hologram based on metasurfaces, which was published in *Nature Nanotechnology* (2015, 10: 308—315).

In the recent years, research on metamaterials has led to many unconventional optical properties and interesting physics. Despite many potential applications have been claimed, so far practical applications with metamaterials are extremely rare, especially at the optical regime. In this work, using a metasurface comprising an array of metallic nanorods with different orientations and a backreflector, an extremely high fidelity hologram image can be obtained in the visible and near-infrared with diffractive efficiency exceeding 80%. The high efficiency arises from the combination of localized plasmon resonance of the individual nanorod and the Fabry Perot resonance between the nanorods layer and the backreflector. More importantly, fabricating such metasurfaces with a continuous phase profile only requires a single lithography step, which is in stark contrast to the complicated lithography steps for making traditional multi-level holograms. Consequently, the metasurface hologram technique significantly reduces the cost of manufacture. This technique will greatly impact the field of holography, and will be applied in various areas including holographic displays, laser beam shaping, data storage, optical trapping and micromanipulation in atom traps and diffractive laser tweezers, laser holographic keyboard, random spots generator for body motion and optical anti-counterfeiting.

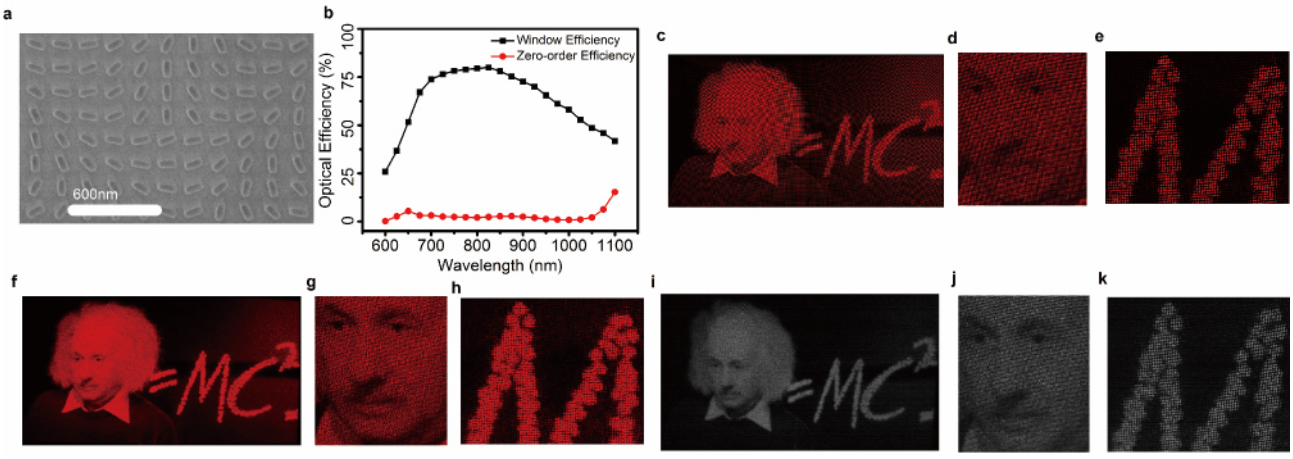

Figure Experimental results for the holographic image generation. a, Scanning electron microscopy image of the fabricated nanorod array (partial view). b, Experimentally obtained optical efficiency for both image and 0^{th}-order beam. The measurements show very high optical efficiency above 50% for the image beam over a range of 630—1050 nm. c-e, Simulated holographic image of Einstein's portrait with enlarged zoom of his face and the character "*M*". f, g and h, Experimentally obtained images that are captured by a visible camera in a far field. The operation wavelength is 632.8 nm. i—k, Experimentally obtained images that are captured by an infrared camera in the far field, the operation wavelength is 780 nm.