Super-resolution imaging beyond the near-field

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We report a new technique for sub-wavelength imaging of complex objects in the far-field using a quasiperiodic nanohole array as an imaging lens. Nanohole arrays in metal screens have exhibited many interesting optical properties, including extraordinary transmission of light through periodic and quasiperiodic nanoholes and optical energy concentration [1, 2]. We have demonstrated that a quasiperiodic array of nanoholes in a metal screen can concentrate optical energy into hot spots and form sub-wavelength spots in the far-field of the array [1, 2] and can be used to image multiple point sources [3]. Here we extend that demonstration to show that a quasiperiodic nanohole array can be used to image more complex structures, such as an array of slits, in the far-field and with sub-wavelength resolution. Figure 1 (a) shows the imaging arrangement, using a quasiperiodic hole array in the

place of a conventional lens. The object structure consists of an array of 10 slits, each 300nm × 1.5μm, with a pitch of 600nm and a wavelength of 660nm. The object is 13.5μm away from the quasiperiodic nanohole array and an image is formed 13.5μm behind the array. Assuming the grating lines are incoherent, as would be the case in a biological experiment using fluorescence imaging, the grating can be clearly resolved, with a measured average period of 603.6nm.This shows the use of a quasiperiodic hole array as a far-field sub-wavelength imaging device, in a form that is simple to manufacture and include in a realistic imaging system.

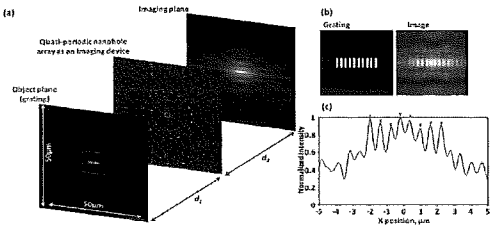

Figure 1. (a) The schematic diagram of the imaging system using a quasi-periodic nanohole array (20-fold symmetry, hole diameter 200nm). The period of grating is 600nm and the width and length of each slit is 300nm and 1.5μm, respectively. (slit separation: 300nm) The image size is 50μm × 50μm. (b) Enlarged images of object and image planes (10μm ×10μm). (c) The cross-section of the imaged grating shows the averaged period of 603.6nm.

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[3] Huang F M, Kao T S, Fedotov V A, Chen Y and Zheludev N I *Nano Lett.* **8**, 2469-72 (2008)