Title: Rapid Optically Directed Assembly of Nano-Patterned Metasurfaces with colloidal Nanoparticles

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Abstract :

Plasmonic metasurfaces are emerging as two-dimentional metamaterials capable of manipulating the phase, amplitude, and polarization of light on the nanoscale, which have been successfully demonstrated as abundant promising applications in advanced photonic devices. Plasmonic nano-patterned colloidal metasurfaces enable light manipulation at the nanoscale. However, a fast and controllable fabrication for such structures remains a major challenge in nano-optics. Here, we propose a strategy for rapid optically directed assembly (ODA) of colloidal metallic metasurfaces with ordered nano-patterns using orthogonal laser standing evanescent wave (LSEW) fields within less than 10 minutes. We demonstrate the underlying cooperative mechanism of optical forces exertions on colloidal nanoparticles (NPs) in orthogonal LSEW fields with a non-focused ultralow fluence irradiation of 0.25 Wcm^{-2}, which leads to the formation of nano-patterned colloidal silver metasurface with a large area of 50 mm^2. The demonstration of polarizations stabilizing during the nano-patterns formation confirmed by a polarization-dependent surface enhanced Raman spectroscopy (p-SERS) characterization substantiates further the interpretation of dynamical driving and binding processes of ODA. This unique combination of top-down nanostructured optical fields directing and bottom-up assembly provide an important foundation for designing and fabricating reconfigurable colloidal nano-patterned metasurfaces for nanoscale control of optical fields. This study constitutes the fundamental step for the fabrication of complex functional nanostructures based on the assembled NPs, which provides the capabilities and applications of optical trapping in new and intriguing ways and offers the perspectives on the rapidly emerging areas of nano-photonics and nano-biology.

Image

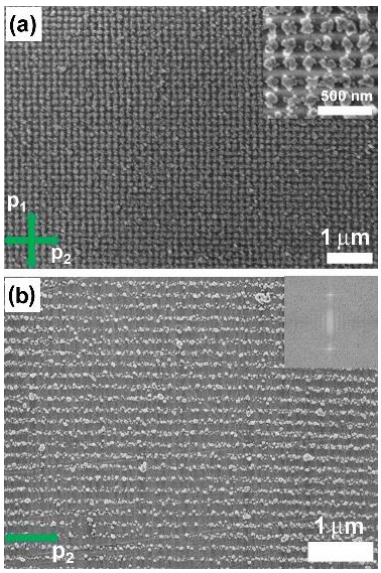


Figure 1: The SEM images of the nano-patterned colloidal metasurface fabricated by the ODA method in solution with two orthogonal (a), and one LSEW illumination (b).

Recent Publications

1. Yu NF and Capasso F. 2014. Flat optics with designer metasurfaces, Nature Materials, 13: 139-150.
2. Huang XP, Chen K, Qi MX, Yu Li, Hou YM, Wang Y, Zhao Q, Luo XG and Xu QY.2016. Nanostructured grating patterns over a large area fabricated by optically directed assembly, Nanoscale, 8: 13342-13351.
3. Moreau A, Ciracì C, Jack JM, Ryan TH, Wang Q, Benjamin JW, Chilkoti A & David RS.2012. Controlled-reflectance surfaces with film-coupled colloidal nanoantennas, Nature, 492:86-89.
4. Matthew JR, David AR, Tyler JD, & Andrea RT, 2015. Colloidal metasurfaces displaying near-ideal and tunable light absorbance in the infrared, Nature Communications, 6:7325.
5. Gao DL, Ding WQ, Manuel NV, Ding XM, Rahman M.2017. Optical manipulation from the microscale to the nanoscale: fundamentals, advances and prospects, Light: Science & Applications, 6: e17039.



Biography (150 word limit)

Dr. Xiaoping Huang is an associate professor in School of Physical Electronics, University of Electronic Science and Technology of China. In 2008, he graduated from the National Laboratory of Solid Microstructures Physics, Department of Physics, Nanjing University. He works in Helmholtz-Zentrum Dresden-Rossendorf as a visiting scientist since 2017. He mainly engages in the fabrication of nanoscale nanostructures of metal and organic functions in the field of nano-optical device physics and the study of the optical and electromagnetics properties. He has published more than 30 international research papers, 5 bulletin, 2 book chapters and 10 patents. Also handled 5 funded national projects including National Science Foundation of China, 2 National Key Projects for Basic Researches of China and 2 International S&T Cooperation Program of China.

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NOTES/ COMMENTS