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RAPID OPTICALLY DIRECTED ASSEMBLY OF NANO-PATTERNED METASURFACES WITH COLLOIDAL NANOPARTICLES

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Plasmonic metasurfaces are emerging as two-dimensional 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 metasurfaces with a large area of 50 mm2. 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.

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