Hierarchical Nanostructures Created by Multi-Beam Interference from High-Order Diffractions

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Hierarchical and periodic nanostructures have unique optical properties; for examples, periodic dielectric structures have photonic bandgap and hierarchical metallic nanostructures possess surface plasmon resonance. Although conventional interference lithography can produce such nanostructures with low defect and high reproducibility, structural complexity is still insufficient for many applications, thereby requiring additional structuring processes. To overcome such limitation, we introduce high-order diffraction beams in interference lithography. Unlike conventional interference lithography which uses only interference between 0th- and 1st-order diffraction beams on Fresnel diffraction region, we use a diffraction grating which can generate high-order diffraction beams and create complex and unique light intensity patterns. The intensity pattern can be transferred into the thin-film of photoresist film, making hierarchical nanostructures with advanced complexity. All the experimental results are in good agreement with finite-difference time-domain (FDTD) calculation. Resulting nanostructures have great potential for a wide range of application requiring periodic and hierarchical nanostructures such as SPR biosensors and superhydrophobic coating.