DIRECT LASER WRITING OF PLASMONIC GRATINGS: OPTICAL RESPONSE AND APPLICATIONS

Rodrigas Liudvinavičius[1], Evaldas Stankevičius[1]

[1]Center for Physical Sciences and Technology, Laser Technology Department, Vilnius, Lithuania
rodrigas.liudvinavicius@ftmc.lt

In recent years, nanotechnology has attracted significant attention due to the successful integration of plasmonic nanostructures into optical sensing platforms and advanced photonic devices. Metallic nanostructures, particularly those based on noble metals such as gold, exhibit strong plasmonic resonances arising from the interaction between electromagnetic radiation and collective electron oscillations. These properties make plasmonic gratings and periodic nanostructure arrays highly attractive for applications in sensing, spectroscopy, and nanophotonics.

Conventional fabrication of plasmonic nanostructures typically relies on electron-beam or focused ion beam lithography, which provide high resolution but are limited by low throughput, high cost, and limited scalability. In contrast, direct laser writing (DLW) has emerged as a versatile, mask-free, and chemically clean fabrication approach that enables fast fabrication of large-area plasmonic structures with controlled morphology. Based on recent experimental studies, this work focuses on the formation of plasmonic gratings composed of laser-induced micro- and nanostructures in thin metallic films using femtosecond laser pulses.

The research investigates the optical response of plasmonic gratings fabricated by DLW, exhibiting grating-coupled surface plasmon resonances and hybrid lattice plasmon modes [1, 2]. Recent results demonstrate that optimization of laser processing parameters allows the fabrication of highly uniform periodic arrays supporting narrow, high-quality plasmonic resonances. The influence of material choice, adhesion layers [1], and array geometry on resonance quality is discussed, highlighting strategies that improve both optical performance and structural integrity (resilience to the environment). Special attention is given to the role of array size and measurement conditions in evaluating plasmonic response. It is shown that resonance quality is not determined only by structure geometry, but also by the grating size. By matching array dimensions to the optical measurement beam and using measuring beam limiting diaphragms, fabrication time can be significantly reduced while preserving high-quality optical response [3].

The results demonstrate the potential of direct laser writing as a scalable method for plasmonic grating fabrication and open new possibilities for practical plasmonic devices in sensing [3], spectroscopy [4], and other fields.

Keywords: Lasers, Plasmonics, Resonance, Raman, Sensing

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