FS - LASER ABLATION AND MODIFICATION OF THIN METAL FOR PERIODIC PLASMONIC ARRAYS

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Various precious metals (such as gold, silver, and platinum) are widely studied for their applications in surface-enhanced Raman spectroscopy (SERS) [1], solar panels [2], and biological and chemical sensors [3]. By having metallic nanostructures, the free electron oscillations can be easily excited in these by incident light. The oscillations, known as localized surface plasmons (LSPs), have distinctive optical properties but are localized to the structure. When these are arranged in an orderly manner with a certain characteristic period length, the array of structures acts as a diffraction grating. A surface plasmon polariton is excited and the surface exhibits a hybrid lattice plasmon resonance (HLPR) characterized by its very narrow resonance and high-quality factor along with dispersive properties.

The structures can be formed either by the ablation of the metal, as the non-removed material acts as a plasmonic grating, or by modification as the plasmons are excited in the affected zones. Although nanostructures are usually formed precisely by photolithography [4], such techniques are expensive and difficult to scale up to large-scale production. Direct laser writing (DLW) is an attractive and fast alternative that allows easy fine-tuning of HLPR properties microstructures. The formation mechanism and properties of the structures formed by a focused laser pulse depend on the beam overlapping and pulse energy used [5].

This study investigates the formation of periodic arrays on thin gold film using layer ablation and modification with the third harmonic (343 nm) of a femtosecond laser. The grating properties were compared with respect to their formation mechanism. The ablated structures act as 1D-like grating, while modification enables the formation of both 1D-like and 2D-like arrays. Also, the dependence of HLPR on the polarization and angle of incident light was researched.

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