ABSTRACT

Devices made from metallic nanostructures and metallic thin films have been extensively studied due to their vast potential in the different fields such as sensing, optical switching, memory devices, photodetectors, solar cells, tunable filters, and photo-thermal therapy. Several advantageous properties stem from plasmon-related effects of the metallic nanoparticles and they are easily adaptable to a vast array of applications. Excitation of surface plasmons in plasmonic nanostructures and thin films through SPR (surface plasmon resonance) and LSPR (localized surface plasmon resonance) leads to the high electric-field enhancements around the metallic nanostructures or thin films, which enable SERS (surface-enhanced Raman scattering) based sensors to be employed for sensitive and selective identification of chemicals and biological molecules. Moreover, SPR and LSPR based plasmonic sensors are extensively employed to measure variations in refractive indices in the bulk media surrounding the metallic nanostructures or in the close proximity of metallic nanostructures with nanoscale dimensions.

A novel nanostructure consisting of a cross-shaped nanoaperture nanoantenna inside plasmonic nanorings for achieving very large values of electric field enhancement, as well as large theoretical surface-enhanced Raman scattering (SERS) enhancement factors, is presented. In this work, we employed Finite-Difference-Time-Domain (FDTD) numerical modelling to simulate the plasmonic (gold) nanostructures present on silica substrates. The electric field enhancements and the resonance wavelengths of nanostructures can be tuned in the visible and the NIR region by modifying the nanostructure dimensions.

Nanostructure based plasmonic sensing platforms have several advantages such as label-free detection of biomolecules in the Visible and IR region. However, to improve their sensing capabilities in the UV spectral regime remains a significant challenges. Therefore, we have proposed a 1-D Al plasmonic nanograting sensors for bulk and localized changes of refractive

index in the UV spectral region. Rigorous coupled wave analysis (RCWA) and finite difference time domain (FDTD) methods are used for optimization of different grating parameters to get the reflectance spectra in the UV region. Performance characteristics like sensitivity and FOM calculated for bulk and localized sensing of biomolecules. These nanogratings have very high sensitivity in the UV spectral regime. The proposed nanograting-based SPR sensors can be used for chemical sensing, for bio-sensing, and for medical applications.

We also present a theoretical study of the optical properties of periodic nanohole arrays in aluminium (Al) thin films, wherein the optical transmission spectra, the near-field intensity enhancement, as well as the plasmon resonance wavelengths lies in the UV and DUV regime. Using FDTD simulations, we studied the applicability of these Al based nanohole arrays for carrying out bulk and localized sensing in the UV spectral regime. In these Al plasmonic nanohole arrays, surface plasmon polaritons can be directly excited by normally incident radiation without employing prism coupling mechanism. We modeled the different structural properties and geometries of the plasmonic nanohole arrays to obtain the plasmon resonance related dips in the UV region.