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Extraordinary optical transmission (EOT) in tapered nano-hole array for bio-chemical sensors application

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Abstract

Transmission enhancement of light through nanoscale holes or slits arrays in noble metal films has been an active research area back to 1998 when extraordinary transmission phenomenon was observed by Ebbesen et. al. Due to limit of nanofabrication, the nano-hole array (NHA) patterned in a noble metal film always has a non-vertical sidewall profile. There are three main methods that have been employed to pattern NHAs in a noble metal (e.g. Au or Ag) film, all of which lead to a tapered profile. The most popular method is focused ion beam (FIB) milling of holes into the metal film. A more efficient method for EOT device fabrication is nanoimprint/electron beam lithography followed by a liftoff process. However, the profile is tapered due to the lateral deposition of the noble metal during evaporation. The third method involves the fabrication of free standing thin (i.e.100s nm) membrane having hole array pattern, followed by evaporation of noble metal on top of it which leads to a negative tapered profile (i.e. opening becomes smaller toward the top of the hole).

In this talk the optical behavior of non-vertical profile of NHA at different tapered angle and geometrical parameters is investigated by showing the examples of numerical and experimental results of positive and negative NHA profiles. The optimum geometrical parameters such as structural period, tapered angle and hole radius are demonstrated for higher transmission peaks and narrow peak line width which leads to increase the EOT device sensitivity.

The effects of varying the refractive index of supporting material of the NHA on the optical transmission spectra are also studied and the optimum substrate refractive index which produces higher transmission peak and narrow peak line width is also reported.

Biography

Mehrdad Irannejad is optical Materials scientist, specializing in plasmonic devices and laser host materials engineering based on glass, glass-semiconductor and glass-polymer composite materials. He obtained his Ph.D (University of Leeds, UK in 2012) in Photonics Materials Science Engineering and Master's degree (University of Leeds, UK, 2008) in Nanoelectronic and Photonic Components Engineering. He is currently Postdoctoral Research Fellow at Waterloo Institute for Nanotechnology (WIN) at University of Waterloo, ON, Canada. His research interests include engineering of plasmonic devices, graphene electronics, laser hosts, glass-semiconductor integration and thin film technology. Dr. Irannejad has membership of OSA, IEEE and IoP.