LOCALIZATION-BASED OPTOFLUIDIC MOLECULAR DETECTION USING PLASMONIC NANOAPERTURE ARRAYS

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In this presentation, optical molecular detection techniques based on light localization are explored for optofluidic applications. For improved sensor characteristics in surface plasmon resonance (SPR) detection, surface-enhanced nanoarray structures have been investigated to create locally amplified electromagnetic near-fields on metallic substrates. Surface-enhanced plasmonic nanoarrays structures can create locally amplified electromagnetic near-fields as a consequence of evanescent field localization on metallic substrates. While the effect of light localization in the near-field using plasmonic nanoarrays may be moderate, the approach can be powerful when localized light fields are spatially colocalized with target molecular distribution. As such, various approaches to produce field matter colocalization for applications in detecting molecular interactions are to be discussed, for example, by oblique evaporation-based device fabrication and plasmonic lithography [1-5].

On the other hand, colocalization can be extended on a broader scale to general biomolecular detection beyond SPR and applied to microscopy and imaging. The creation of localized fields has been investigated in many studies in the past because of the potential to improve resolving power for imaging molecular processes typically impossible to observe under diffraction limit. Although emerging approaches have been extremely successful to produce super-resolved images, we explore alternative techniques based on plasmonic nanoarrays by which achievable resolution may be customized to fit the specific imaging needs and at the same time a conventional optical system may be used. Feasibility studies performed on visualizing internalization of virus particles [6], sliding microtubules and bacterial motility on random and periodic nanopatterns will be discussed [7-11]. Enhancement of axial resolution for the detection of intracellular protein distribution is also reported by extraordinary light transmission using graded plasmonic nanoapertures.

It is also imperative to understand the force acting on molecules under detection for sensor and imaging applications. Figure 1a-c shows the gradient force produced by a plasmonic nanopost of diameter ϕ = 100, 150, and 200 nm (height: 30 nm, gap between posts: 100 nm, and period: 750 nm) and clearly confirms the trapping force exerted at the post rim. Spectra of electric near-field maximum are also presented in Figure 1d (at the wavelength at which a maximum field strength is obtained for each nanopost, the gradient force in Fig. 1a-c was calculated). The results suggest the possibility of wavelength-dependent switching of the trapping force. This is only one of many application examples of the trapping force that can be applied and has thus been pursued in various optofluidic systems.

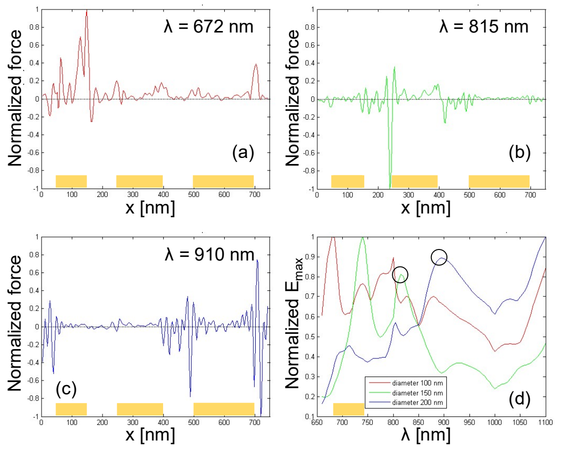

Fig.1 Gradient force produced by a plasmonic nanopost: (a) ϕ = 100 nm, (b) 150 nm, and (c) 200nm. The force was calculated at the resonant wavelength shown. (d) shows the normalized maximum electric field strength in a spectral band of λ = 650 ~ 1100 nm.

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