Plasmonic random laser biosensor on fiber facet for label-free detecting biomolecules

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Abstract
Low-cost and miniaturized biosensors are key factors leading to the possibility of portable and integrated biomedical system, which play an important role in clinical medicine and life sciences. Random lasers with simple structures provide opportunities for detecting biomolecules. Here, a low-cost biosensors on fiber facet for label-free detecting biomolecules is demonstrated resorting to plasmonic random laser. The random laser is achieved resorting to a random plasmonic scattering structure of Ag nanoparticles and polymer film on fiber facet. Refractive index sensitivity and near-surface sensitivity of the biosensor are systematically studied. Furthermore, the biosensor is used to detect IgG through specific binding to protein A, exhibiting the detecting limit of 0.68 nM. It is believed that this work may promote the applications of plasmonic random laser bio-probe in portable or integrated medical diagnostic platforms, and provide fundamental understanding for the life science.

Full Text
Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures
Figure 1

Figure 1 (a) Schematic illustration of the synthesis process for scattering structure on fiber facet (b) Scanning electron microscopy (SEM) image of Ag NPs self assembled on fiber facet. (c) Statistical distribution of Ag NPs that self assembled on fiber facet d ) The extinction spectrum of Ag NPs. Inset: the normalized electric field intensity of Ag NPs, the excitation is a plane wave polarized in the x axis with a wavelength of 466 nm.
Figure 2

(a) Design of the plasmonic random laser on fiber facet (b) Absorption spectra (blue dash) and hotoluminescence spectra of PFO blue solid)), hotoluminescence spectra of polymer with Ag N P s red solid) (The PL lifetime of PFO with (red dots) and without Ag N P s (blue dots) (d) The normalized electric field intensity of Ag N P s on the fiber facet covered by PFO, the excitation is a plane wave polarized in the x axis with a wavelength of 466 nm.
(a) Experimental setup of plasmonic random lasers on fiber facet. (b) Emission spectra of the plasmonic random system on fiber facet obtained under different pump power densities at the detection angle of 45°. (c) Specifics of emission spectra at pump power density of 33 μJ/cm², recorded by a high-resolution spectrometer with a resolution of 0.1 nm. (d) Emission intensity of random lasing mode at 468 nm versus the pump energy density. (e) The integrated intensity of the random laser as a function of the detection angle.
Figure 4

(a) The variation of wavelength shifts versus of external environment by exposing different solutions to the RL surface surface. (b) Dynamic detection of alternating deposition layers of single monolayer PPL.
Figure 5

Figure 5 (a) Schematic diagram of capture immunoassay employed for IgG detection. Corresponding spectra of the RL based sensor before functionalization with protein A (red line) and after being cultivated in IgG solution for 15 min (red c) The temporal behavior of wavelength shift for the biosensors exposed to IgG with the concentrations of 34 μM (d) The variation of wavelength shift as a function of IgG solution with different concentrations. Error bars represent the minimum value and maximum value of wavelength shift from the emission spectra acquired over 5 times.