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The 4th ASIAN AND PACIFIC RIM SYMPOSIUM ON BIOPHOTONICS

Date	:	27-29, May 2009
Location	:	Shilla Hotel, Jeju island, Korea
Organized by	:	Optical Society of Korea / Biomedical Optics Division
Sponsored by	:	Korea Optical Industry Association Advanced Photonics Research Institute, GIST Graduate-program of Medical System Engineering(GMSE), GIST Chungbuk BIT Research-Oriented University Consortium Intelligent System Research Division, KIST SeongKeong Photonics HANA engineering Co., Ltd. Huentek Co., Ltd. Fovice Co. Ainnotech Inc.

International Commission for Optics
Commission Internationale d' Optique

OSK Optical Society of Korea

EOS European Optical Society — Coherence for Europe

SPIE

The American Optics Society

OSA

OWLS

APBP Poster presentation

17:00-19:00, Thursday, May 28

Optical Coherence Tomography

[OCT-P1] Endoscopic common-path OCT with flexible optical fiber probe, Jae Seok Park, et al. (Korea)
[OCT-P2] Development of high-resolution high-speed spectral domain OCT for volumetric imaging, Cheol Song, et al. (Korea)
[OCT-P3] Absolute wavelength calibration for spectral-domain OCT using fiber Bragg gratings, Tae Joong Eom, et al. (Korea)
[OCT-P4] Spectral-domain OCT having compact handheld probe for dermatology applications, Eun Jung Min, et al. (Korea)
[OCT-P5] Refocusing technique with phase shifting digital holography based on integrating bucket method, Gi Hyeon Min, et al. (Korea)
[OCT-P6] Application of OCT for colorectal cancer diagnosis, Chih-Wei Lu, et al. (Korea)
[OCT-P7] Dynamic analysis of internal mental sweating by OCT, Motomu Tanigawa, et al. (Japan)
[OCT-P8] Trade-off among axial resolution, depth range, and sensitivity for high-resolution spectral domain OCT at 1.3 μm, Sang-Won Lee, et al. (Korea)
[OCT-P9] Real-time label-free live cancerous cell imaging by using full-field OCT, Woo June Choi, et al. (Korea)
[OCT-P10] Opto-mechanical design and simulation of 2D MEMS lens scanners for OCT based endoscopy, Hyeon-Cheol Park, et al. (Korea)

Optical Microscopy and Nanoscopy

[MIC-P1] Development of reflection and fluorescence hybrid in-vivo confocal microscope, MyoungKi Ahn, et al. (Korea)
[MIC-P2] Excitation energy migration processes in cyclic porphyrin arrays probed by single molecule spectroscopy, Jaesung Yang, et al. (Korea)
[MIC-P3] Shear-force imaging of human hair cuticle damaged by an acid solution, Kyoung-Duck Park, et al. (Korea)
[MIC-P4] Femtosecond transient absorption microscope system for nano-imaging, Sang-Youp Yim, et al. (Korea)
[MIC-P5] High-resolution temporal and spatial PL measurement of semiconductor quantum structures at room temperature, Hong-Gyu Ahn, et al. (Korea)
[MIC-P6] Fluorescence dynamics of directly meso–meso linked porphyrin rings probed by single molecule spectroscopy, Hyejin Yoo, et al. (Korea)
[MIC-P7] Measurement of THG signal in fused silica using third-harmonic generation microscopy, Lee EungJang, et al. (Korea)
[MIC-P8] Nanostructure-based surface plasmon resonance imaging, Dong Jun Kim, et al. (Korea)
[MIC-P9] Implementation of resolution-enhanced integral imaging microscope, Yong-Tae Lim, et al. (Korea)
[MIC-P10] Two-photon photoluminescence imaging of single gold nanorod using polarization selective supercontinuum light, Wei Tao, et al. (Australia)

Optical Spectroscopy for Biomedical Research

[SPE-P1] Differential sensitivity of near-infrared spectroscopy to oxygenation changes in different vascular compartments, T. Eriguchi, et al. (Japan)
[SPE-P2] Changes in cerebral blood oxygenation after subarachnoid hemorrhage evaluated by near-infrared time-resolved spectroscopy, T. Hoshino, et al. (Japan)
[SPE-P3] Influence of the depth of brain activation on wavelength dependence of optical path length, N. Sakashita, et al. (Japan)
[SPE-P4] Monitoring of microvascular reaction in skin tissue by use of multispectral reflectance images, I. Nishidate, et al. (Japan)
[SPE-P5] Investigating the relationships between the backscattering spectrum and nuclear size, Guo-Shan, et al. (Taiwan)
[SPE-P6] The role of NaCl in triple helix DNA formation, Ja Eun Lee, et al. (Korea)
[SPE-P7] Highly sensitive SERS detection of duplex DNAs in a microdroplet channel, C. Lim, B. Han, et al. (U.K.)
[SPE-P8] Highly sensitive immunoassay of cancer markers using SERS of hollow gold nanospheres, H. Chon, et al. (Korea)
[SPE-P9] Biological application of pre-patterned glass microarray chip using hydrophobic/hydrophilic surface modification, M. Lee, et al. (Korea)

Molecular/Cellular Imaging and Manipulation

[MOL-P1] ALEX three-color FRET combined with optical tweezers, Sanghwa Lee (Korea)
[MOL-P2] Single-molecule FRET combined with magnetic tweezers, Heesoo Uhm (Korea)

Diffuse Optics for Biomedical Applications

[DOT-P1] Preclinical study of extremities metabolic detection with a venous occlusion test based on diffuse optical tomography, Yo-Wei Lin, et al. (Taiwan)
[DOT-P2] Effects of the anatomy of the head on optical mapping of brain activities, Ryo Togashi, et al. (Japan)
[DOT-P3] Reduction of Poisson noise from time-resolved data for diffuse optical tomography, Shinpei Okawa, et al. (Japan)
[DOT-P4] Optimisation of algorithm for blood-flow measurement by laser speckle method, Haruka Nakayama, et al. (Japan)
[DOT-P5] Effect of the optical properties of tissue, Yosuke Takahashi, et al. (Japan)
[DOT-P6] Phantom experiments of fluorescence diffuse optical tomography, Yano Akiraet, et al. (Japan)
[DOT-P7] Effect of the movement of probes on the images of diffuse optical tomography, Syoko Matsuhashi, et al. (Japan)
[DOT-P8] Realistic skin and lip models for simulation of diffuse reflectance spectra, Wakana Fujita, et al. (Japan)
[DOT-P9] Optical density spectroscopy of oral cancer ex-vivo using a spatially mapping fiber-optic probe for early diagnosis, Youngjin Oh, et al. (Korea)

Optical Sensing and Measurement

[SEN-P1] Experimental study on estimation parameters in biospeckle blood flow imaging, Yoshihisa Aizu, et al. (Japan)
[SEN-P2] A background-compensated reflection-type pulse oximeter using a gain-enhanced gated avalanche photodiode, Tsuyoshi Miyata, et al. (Japan)
[SEN-P3] Characterization of wavelength swept laser based on fiber F-P tunable filter, Byoung Chang Lee, et al. (Korea)
[SEN-P4] Measurement of charge transfer through DNA on gold electrodes, Hojeong Ryu, et al. (Korea)
[SEN-P5] Sensitivity-enhanced plasmonic detection of DNA hybridization, Seyoung Moon, et al. (Korea)
[SEN-P6] Recognition of incremental changes in corneal ring (arcus-senilis), AMT Nasution, et al. (Indonesia)
[SEN-P7] Investigation of the effect of target localization on the sensitivity enhancement of nanowire-mediated surface plasmon resonance biosensors, Seong Min Jang, et al. (Korea)

Optical Device and Systems for Bioscience

[DEV-P1] New valve and splitter designs for microfluidic biochips containing proteins, Samuel I En Lin (Taiwan)
[DEV-P2] Phase sensitive surface plasmon resonance biosensors using periodic nanowire structures, Kyungjae Ma, et al. (China)
[DEV-P3] Measurement of vascular functions in mice brain using two-photon laser scanning microscopy, Jinho Kim, et al. (Korea)
[DEV-P4] Frequency swept source at 1500 nm with a simple wavelength selection filter for biomedical imaging, Mansik Jeon, et al. (Korea)
[DEV-P5] Optical microscanner with vertical comb electrodes for endoscopic OCT, Min-Ho Jun, et al. (Korea)
[DEV-P6] Transmittance of UV light through TiO2 thin film deposited by ion-assisted electron-beam evaporator, Seon Hoon Kim, et al. (Korea)
[DEV-P7] Novel wavelength-swept FDML laser source using broadband Raman amplifier, Eun Joo Jung, et al. (Korea)
[DEV-P8] Reflectivity tunable Sagnac loop device for the linear cavity of FBG laser system, Tae Ho Lee, et al. (Korea)
[DEV-P9] Quantitative q-dot signal detection by using novel compact laser source, Hyung Man Lee, et al. (Korea)
[DEV-P10] Recognition of incremental changes in corneal ring (arcus senilis) using hybrid N-feature neural network (HNFNN), Aulia M T Nasution, et al. (Indonesia)

Investigation of the effect of target localization on the sensitivity enhancement of nanowire-mediated surface plasmon resonance biosensors

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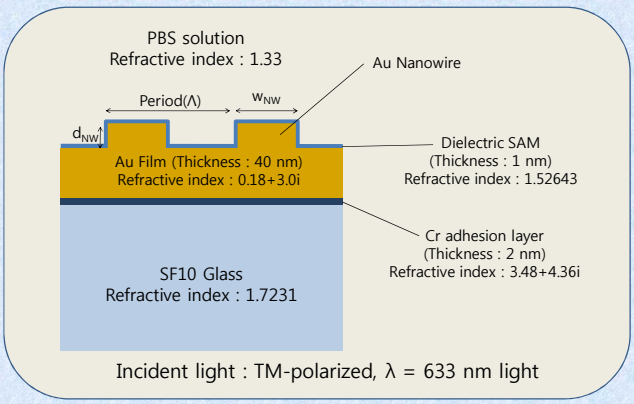
Introduction

Surface plasmon resonance(SPR) has been widely used in optical biosensors, since it has advantages of rapid, label-free, and real-time detection. And our group previously employed nanowire structures on the sensor surface to overcome sensitivity limits of the conventional SPR biosensor. As a result, optimal nanowire structures can provide sensitivity enhancement more than an order, compared to conventional SPR biosensors.

In this study, we quantitatively investigated the effect of target localization on the sensitivity enhancement of the nanowire-mediated SPR sensor. Since the local field amplification by nanostructures is known to contribute to the enhancement of optical transitions in biomolecules, we also considered the spatial distribution of localized plasmonic fields on a sensor surface.

Numerical Model

Schematic of a Nanowire-mediated Gold Substrate



SAM_T, SAM_S, SAM_B, and SAM_{ALL}

Target analytes are assumed as 1-nm thin layer of self-assembled monolayer(SAM). To investigate the effect of target localization, we divided the SAM layer into three localization regions: nanowire top(SAM_T), sidewalls(SAM_S), bottom area(SAM_B). In addition, SAM_{ALL} represents uniform target on the sensor surface.

Volume Factor (VF)

We denote VF as the ratio of the volume occupied by gold nanowires per period, i.e. VF = w_{NW} / Λ.

Sensitivity Enhancement Factor (SEF) and Sensitivity Enhancement per Target Unit (SEF_{UTV})

SEF and SEF_{UTV} are introduced for quantitatively estimating enhanced sensitivity. SEF is defined as

$$\mathrm{SEF} = \frac{\Delta\theta_{\mathrm{NWSPR}}}{\Delta\theta_{\mathrm{SPR}}} = \frac{\theta_{\mathrm{NWSPR}}(\text{target}) - \theta_{\mathrm{NWSPR}}(\text{no target})}{\theta_{\mathrm{SPR}}(\text{target}) - \theta_{\mathrm{SPR}}(\text{no target})}$$

where θ_{NWSPR} and θ_{SPR} indicate the resonance angles with and without nanowires. The value of $\Delta\theta_{SPR}$ is 0.19°.
And SEF_{UTV} is defined as

$$\mathrm{SEF}_{\mathrm{UTV}} = \frac{\Delta\theta_{\mathrm{NWSPR}} / \mathrm{V}_{\mathrm{NWSPR}}}{\Delta\theta_{\mathrm{SPR}} / \mathrm{V}_{\mathrm{SPR}}}$$

where V_{NWSPR} and V_{SPR} denote the total target volume for nanowire-based SPR and conventional SPR structures.

Result and Discussion

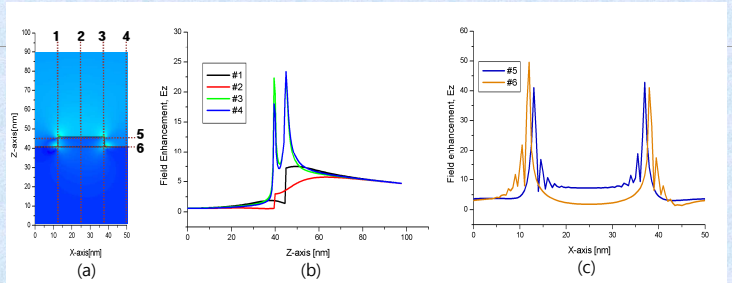
SEF and SEF_{UTV} Values of SAM_T, SAM_S, SAM_B, and SAM_{ALL}

SEF					SEF_{UTV}				
d_{NW} [nm]	SAM_T	SAM_B	SAM_S	SAM_{ALL}	d_{NW} [nm]	SAM_T	SAM_B	SAM_S	SAM_{ALL}
5	1.421	1.579	2.684	5.895	5	2.842	3.158	13.420	4.913
10	2.947	5.894	5.684	8.474	10	5.894	5.790	14.210	6.053

The tables above show SEF(left) and SEF_{UTV}(right) values of the structure. The period and VF of the nanowires are identical to all samples as Λ = 50 nm and VF = 0.5. According to the tables, the target on the sidewalls contributes most to the overall sensitivity enhancement. Particularly, in the right table, the target on the sidewalls enhances the sensitivity by more than an order.

Spatial Distribution of Electromagnetic Field

The results above appear to be originated from the effect of strong surface field from localized surface plasmons(LSPs) covering localized target. To prove this, we investigated the spatial distribution of E_x, H_y, and E_z fields using finite-difference time domain(FDTD) method. Following graphs show field distribution of d_{nw} = 5 nm sample.



E_z-field distribution of the (a)entire structure, (b)vertical section, and (c)horizontal section

As indicated on the graphs, biomolecules on sidewalls can be affected to LSPs stronger than those on bottom and top, and finally it can enhance sensitivity of the SPR biosensor significantly.
Although not shown here, E_x and H_y field of this sample, and field distribution of d_{nw} = 10 nm sample show similar results.

Conclusion

We investigated the effect of target localization on the sensitivity enhancement. Especially, targets bound on nanowire sidewalls can contribute significanlty to the overall sensitivity enhancement. This study shows a potential for developing a highly sensitive SPR biosensor using periodic metallic nanowires.

Acknowledgment

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