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Functionalization of gold-plasmonic devices for protein capture

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Abstract

Here we propose a straightforward method to functionalize gold nanostructures by using an appropriate peptide sequence already selected toward gold surfaces and derivatized with another sequence for the capture of a molecular target. Large scale 3D-plasmonic devices with different nanostructures were fabricated by means of direct nanoimprint technique. The present work is aimed to address different innovative aspects related to the fabrication of large-area 3D plasmonic arrays, their direct and easy functionalization with capture elements, and their spectroscopic verifications through enhanced Raman and enhanced fluorescence techniques.

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Keywords: nanoCones, surface functionalization; gold binding peptide; fluorescence enhancement; plasmonic device; SERS

1. Main text

In recent years, plasmonic has attracted lots of attention due to its application in different fields such as photonic crystals, waveguides, biosensors, light harvesting, etc. [*1- 4*]. It is blooming new field of science and technology, which exploits the distinctive optical properties of metallic nanostructures to generate, localize and guide light at

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nanometric scale. However in order to give specific recognition features of the device the interface should be modified with appropriate capture molecules. Different approaches were employed to firmly bind the captured molecules which, however, require chemical building blocks difficult to manipulate and to obtain large area functionalizations (i.e. for self assembled molecules (SAM)). Here we propose a straightforward method to functionalize gold nanostructures by using an appropriate peptide sequence already selected toward gold surfaces and derivatized with another sequence for the capture of a molecular target [*5, 6*]. In this regard, large scale 3D-plasmonic devices with different nanostructures were fabricated by means of direct nanoimprint technique [7]. The selective functionalization of gold surfaces was proposed by using a peptide (AuPi3= TLLVIRGLPGAC) previously selected by phage display [7]. In this regard, two different gold binding peptides, AuPi3-G_4-RGD (GBP) sequences labeled with fluorescein (GBP-FITC) and biotin (GBP-biotin), were chemisorbed on metallic surfaces from diluted buffered solutions (about 30μM). The presence of peptide on Au nanoCones array consents an enhancement in electric field on the apex of cone, enabling the detection of molecules of stable and brighter fluorescent emission. Furthermore, a sharp decrease in fluorescence lifetime over nanoCones confirms the increase in radiative emission (i.e., an increase in photonics density at the apex of cones). Additionally, we have witnessed around 12-fold increase in fluorescence intensity and SERS enhancement factor around 1.75×10^5 with respect to the flat gold surface.

The easy, flexible and cheap fabrication and functionalization of large areas of nanoCones array was presented as the basis for new substrates to be used for bio-/chemical- analysis opening the way to their large-scale applications for high sensitive and multiplex analytical tools.

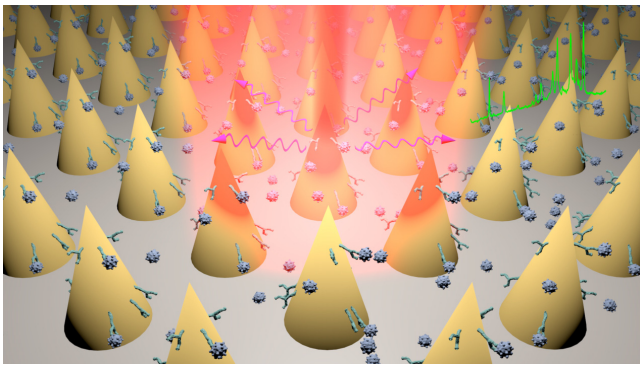

Fig. 1. Large area nanoCones Array was functionalized by peptide chemisorption to realize a specific substrate for the investigation of target molecules by SERS and fluorescence with high sensitivity.

References

[1] Das G, Chirumamilla M, Gopalakrishnan A, Toma A, Panaro S, Proietti Zaccaria R, De Angelis F, Di Fabrizio E. Plasmonic nanostars for SERS application Microelectron. Eng. 2013; 111, pp. 247-250. DOI: 10.1016/j.mee.2013.04.028

[2] Manikas AC, Aliberti A, Causa F, Battista E, Netti PA. Thermoresponsive PNIPAAm hydrogel scaffolds with encapsulated AuNPs show high analyte-trapping ability and tailored plasmonic properties for high sensing efficiency. J. Mater. Chem. B 2014; 3 (1), pp. 53.

[3] Das G, Chirumamilla M, Toma A, Gopalakrishnan A, Panaro S, Proietti Zaccaria R, Alabastri A, Leoncini M, Di Fabrizio E, Plasmon based biosensor for distinguishing different peptides mutation states, Sci. Rep., 2013; 3, pp. 1792. DOI:10.1038/srep01792.

[4] Proietti Zaccaria R, Bisio F, Das G, Maidecchi G, Caminale M, Chinh Duc Vu, De Angelis F, Di Fabrizio E, Toma A, Canepa M, Plasmonic color-graded nanosystems with achromatic subwavelength architectures for light filtering and advanced sers detection, ACS Appl. Mat. Interface, 2016; 8 (12), pp. 8024-8031. DOI**:** 10.1021/acsami.6b00726

[5] Causa F, Della Moglie R, Iaccino E, Mimmi S, Marasco D, Scognamiglio PL, Battista E, Palmieri C, Cosenza C, Sanguigno L, Quinto I, Scala G, Netti PA. Evolutionary screening and adsorption behavior of engineered M13 bacteriophage and derived dodecapeptide for selective decoration of gold interfaces. J. Colloid Interface Sci. 2013; 389 (1), pp. 220-229. DOI: 10.1016/j.jcis.2012.08.046

[6] Cusano AM, Causa F, Della Moglie R, Falco N, Scognamiglio PL, Aliberti A, Vecchione R, Battista E, Marasco D, Savarese M, Raucci U, Rega N, Netti PA. Integration of binding peptide selection and multifunctional particles as tool-box for capture of soluble proteins in serum. J. R. Soc. Interface 2014, 11 (99), art. no. 0718. DOI: 10.1098/rsif.2014.0718

[7] Das G, Battista E, Manzo G, Causa F, Netti PA, Di Fabrizio E. Large-Scale Plasmonic nanoCones Array for Spectroscopy Detection. ACS Appl. Mater. Interfaces 2015; 7 (42), pp. 23597-23604. DOI: 10.1021/acsami.5b06887