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Abstract

Plasmonic hydrogel nanocomposites with combined optical and mechanical properties for biochemical sensing †

Bruno Miranda [1,2,*], Rosalba Moretta[1], Selene De Martino[3], Principia Dardano[1], Ilaria Rea[1], Carlo Forestiere[2], Luca De Stefano[1]

[1] Institute of Applied Sciences and Intelligent Systems, via P. Castellino 111, Naples, 80131, Italy
[2] DIETI, University of Naples "Federico II", via Claudio 21, Naples, 80125, Italy
[3] Materias s.r.l., via Protopisani 50, Naples, 80131, Italy
* Correspondence: bruno.miranda@na.isasi.cnr.it;
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Abstract: Localized Surface Plasmon Resonance (LSPR) and Metal-Enhanced Fluorescence (MEF)-based optical biosensors provide unique advantages compared to other sensing technologies to design point-of-care (POC) diagnostic tools. These devices exploit the capability of noble-metal nanoparticles of absorbing light at a well-defined wavelength. The need for wearable, flexible and easy-to-use diagnostic tools has brought to the development of plasmonic nanocomposites, whose performances are strongly dependent on both the optical properties of plasmonic nanoparticles and mechanical properties of the polymeric matrix. An optical platform based on spherical gold nanoparticles (AuNPs) embedded in high molecular weight poly-(ethylene glycol) diacrylate (PEGDA) hydrogel is proposed. As a hydrogel, PEGDA represents a biocompatible, flexible, transparent polymeric network to design wearable, 3D, plasmonic biosensors for the detection of targets with different molecular weights for the early diagnosis of disease. The swelling capability of PEGDA is directly correlated to the plasmonic decoupling of AuNPs embedded within the matrix. A study on the effect of swelling on the optical response of the PEGDA/AuNPs composites was investigated in a model system. Specifically, citrate AuNPs were modified with cysteamine, and the interaction biotin-streptavidin is monitored within the 3D hydrogel network. Also, metal-enhanced fluorescence is observed within the PEGDA/AuNPs nanocomposites, which can be exploited to achieve an ultra-low limit of detection. Citrate-stabilized AuNPs (~65 nm) are synthesized via seeded-growth method, embedded in PEGDA 10 kDa pre-polymer solutions, and polymerized by UV light exposure. Citrate-displacement via cysteamine, biotin interaction and Cy3TM-Streptavidin conjugation are performed by soaking the PEGDA/AuNPs nanocomposite in the prepared solutions. LSPR signal was monitored via transmission mode customized setup and MEF signal was detected via Fluorescence and Confocal Microscopes.

Keywords: optical biosensors; flexible hybrid materials; disease early-diagnosis; nanofabrication techniques; nanocomposite materials; LSPR-based biosensors; Metal-Enhanced Fluorescence.

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