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*Abstract*

# Plasmonic Hydrogel Nanocomposites with Combined Optical and Mechanical Properties for Biochemical Sensing †

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**Abstract:** Localized surface plasmon resonance (LSPR) and metal-enhanced-fluorescence (MEF)-based optical biosensors exhibit unique properties compared to other sensing devices that can be exploited for the design point-of-care (POC) diagnostic tools [1]. Plasmonic devices exploit the capability of noble-metal nanoparticles of absorbing light at a well-defined wavelength. The increasing request for wearable, flexible and easy-to-use diagnostic tools has brought to the development of plasmonic nanocomposites, whose peculiar performances arise from the combination of the optical properties of plasmonic nanoparticles and mechanical properties of the polymeric matrix in which they are embedded [2,3]. An optical platform based on spherical gold nanoparticles (AuNPs) embedded in high molecular weight poly-(ethylene glycol) diacrylate (PEGDA) hydrogel is proposed. PEGDA hydrogel 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 by using a biorecognition layer/target model system. Specifically, after the in situ chemical modification of the AuNPs within the hydrogel, the interaction biotin-streptavidin is monitored within the 3D hydrogel network. Additionally, metal-enhanced fluorescence is observed within the PEGDA/AuNPs nanocomposites, which can be exploited to achieve an ultra-low limit of detection. LSPR signal was monitored via transmission mode customized setup and MEF signal was detected via fluorescence and confocal microscopes. Label-free (LSPR-based) and fluorescence (MEF-based) signals of a high molecular weight target analyte were successfully monitored with relatively high resolutions and low limits of detection compared to the standard polymeric optical platforms available in the literature. The optimized platform could represent a highly reproducible and low-cost novel biosensor to be applied as a POC diagnostic tool in healthcare and food monitoring applications.

**Keywords:** optical biosensors; flexible hybrid materials; disease early diagnosis; nanofabrication techniques; nanocomposite materials; LSPR-based biosensors; metal-enhanced fluorescence

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