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Cancer Marker Immunosensing through Surface Enhanced Photoluminescence on Nanostructured Silver Substrates

Xiaoli Duan*

Department of Life Science, Huizhou University, Huizhou, Guangdong, China

Introduction

Cancer detection and diagnosis have been revolutionized by advancements in nanotechnology and surface-enhanced spectroscopy techniques. This article explores the application of Surface-Enhanced Photoluminescence (SEPL) on nanostructured silver substrates for the immunosensing of cancer markers. We delve into the principles behind SEPL, the fabrication of nanostructured silver substrates, and the integration of antibodies for selective cancer marker detection. Additionally, we discuss the potential implications of this technology in early cancer diagnosis and personalized medicine. Cancer remains one of the most pressing health challenges globally, with early detection playing a crucial role in improving patient outcomes. Conventional cancer diagnostics often rely on invasive procedures and may lack sensitivity and specificity. However, emerging technologies, such as surface-enhanced spectroscopy, offer promising avenues for sensitive and selective cancer detection. In this article, we focus on the application of Surface Enhanced Photoluminescence (SEPL) on nanostructured silver substrates for the immunosensing of cancer markers.

Description

Surface-Enhanced Photoluminescence (SEPL) involves the enhancement of luminescence signals from molecules adsorbed on plasmonic nanostructures. This enhancement arises from the Localized Surface Plasmon Resonance (LSPR) effect, where incident light couples with the collective oscillations of conduction electrons in metallic nanostructures. SEPL offers advantages such as high sensitivity, rapid detection, and multiplexing capabilities, making it suitable for various biosensing applications, including cancer diagnostics, Nanostructured silver substrates play a crucial role in SEPL-based biosensing platforms. These substrates typically consist of silver nanoparticles or nanostructures fabricated through techniques such as lithography, chemical synthesis, or template-assisted methods. The high surface area and plasmonic properties of silver nanostructures enable efficient light-matter interactions, leading to enhanced photoluminescence signals. Furthermore, the tunability of silver nanostructures allows optimization for specific bimolecular interactions, enhancing the sensitivity and selectivity of cancer marker detection [1-3].

The immunosensing of cancer markers on nanostructured silver substrates involves the selective capture and detection of specific biomolecules, such as antigens or antibodies, associated with cancer cells. Antibodies specific to target cancer markers are immobilized onto the surface of nanostructured silver substrates through techniques like self-assembly or chemical functionalization. Upon exposure to a sample containing cancer markers, antigen-antibody binding occurs, leading to changes in the photoluminescence intensity or spectral characteristics due to the proximity of fluorophores to the silver nanostructures. By monitoring these changes, the presence and concentration of cancer markers can be determined with high sensitivity and specificity. The integration of SEPL on nanostructured silver substrates for cancer marker immunosensing holds significant potential for early cancer diagnosis. Early detection allows for timely intervention and improved patient outcomes by enabling effective treatment strategies. SEPL-based biosensing platforms offer advantages such as label-free detection, real-time monitoring, and compatibility with complex biological samples, making them promising candidates for point-of-care diagnostics and screening programs. Furthermore, the multiplexing capabilities of SEPL enable simultaneous detection of multiple cancer markers, enhancing diagnostic accuracy and information content [4,5].

Personalized medicine aims to tailor medical treatment and interventions to individual patients based on their unique genetic, environmental, and lifestyle factors. SEPL-based immunosensing platforms can contribute to personalized medicine by facilitating the identification of specific cancer biomarkers associated with patient subtypes or treatment responses. This information can guide treatment selection, dosage optimization, and monitoring of therapeutic efficacy, ultimately improving patient outcomes and minimizing adverse effects. Additionally, the development of portable and miniaturized SEPL devices could enable point-of-care testing in resource-limited settings, extending the benefits of personalized cancer diagnostics to a broader population.

Despite the significant progress in SEPL-based cancer marker immunosensing, several challenges remain to be addressed. These include enhancing the reproducibility and stability of nanostructured silver substrates, improving the specificity of bimolecular recognition, and optimizing assay protocols for clinical translation. Future research efforts should focus on integrating SEPL with other analytical techniques, such as surface-enhanced Raman spectroscopy and electrochemical sensing, to enhance multiplexing capabilities and diagnostic accuracy. Additionally, interdisciplinary collaborations between researchers, clinicians, and industry partners are essential for translating SEPL-based biosensing platforms into clinically viable tools for cancer diagnosis and management.

Conclusion

Surface-Enhanced Photoluminescence (SEPL) on nanostructured silver substrates holds immense potential for the sensitive and selective immunosensing of cancer markers. By leveraging the plasmonic properties of silver nanostructures and the specificity of antibody-antigen interactions, SEPL-based biosensing platforms offer a promising approach for early cancer diagnosis and personalized medicine. Continued research efforts aimed at addressing technical challenges and advancing clinical translation will further enhance the impact of SEPL in improving cancer diagnostics and patient care.

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Conflict of Interest

None.

***Address for Correspondence:** Xiaoli Duan, Department of Life Science, Huizhou University, Huizhou, Guangdong, China, E-mail: xiaoliduan@ubc.ca*

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