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Perspective

An Overview of Detection and Applications of Optical Biosensors

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DESCRIPTION

Biosensors are analytical devices that convert biological or biochemical signals into measurable signals. They are widely used in clinical, environmental, and industrial applications for detection and quantification of biomolecules. Optical biosensors, which use light as a detection signal, have gained significant attention due to their high sensitivity, selectivity, and real-time monitoring capability. In this article, we will provide an overview of optical biosensors, their working principles, and applications.

Working principles of optical biosensors

Optical biosensors can be divided into two main categories based on the mode of detection: label-free and labeled biosensors. Label-free biosensors detect biomolecules directly without using any additional labels or markers, whereas labeled biosensors use fluorescent, chemiluminescent, or electrochemical tags to amplify the signal. Label-free biosensors are preferred due to their simplicity, sensitivity, and low cost. Optical biosensors typically consist of a recognition element, a transducer, and a signal processor. The recognition element is usually a bioreceptor such as an antibody, enzyme, or nucleic acid that specifically binds to the target molecule. The transducer converts the biorecognition event into a measurable signal, usually based on changes in optical properties such as refractive index, absorbance, fluorescence, or surface plasmon resonance. The signal processor then analyzes and quantifies the signal. Surface plasmon resonance (SPR) biosensors are one of the most widely used optical biosensors. SPR is an optical phenomenon that occurs when polarized light is incident on a metal surface, resulting in the excitation of surface plasmons, which are collective oscillations of electrons at the interface of the metal and the surrounding medium. When a bioreceptor is immobilized on the metal surface, binding of the target molecule causes a change in the refractive index of the medium around the metal surface, which alters the SPR angle and intensity. The change in SPR signal is proportional to the concentration of the target molecule. SPR biosensors have several advantages, such as high sensitivity, real-time monitoring, label-free detection, and the ability to analyze complex samples such as serum and plasma. They have been used for detection of various biomolecules, including proteins, nucleic acids, and small molecules, in clinical, environmental, and food safety applications.

Fluorescence biosensors

Fluorescence biosensors use fluorescent tags to detect and quantify biomolecules. Fluorescent molecules are excited by a light source, and they emit light at a higher wavelength, which is detected by a photodetector. The intensity of fluorescence is proportional to the amount of biomolecule present in the sample. Fluorescence biosensors have high sensitivity and specificity, and they can be used for real-time monitoring of biological processes. They have been used for detection of various biomolecules such as proteins, nucleic acids, and metabolites in clinical and environmental applications.

Applications of optical biosensors

Optical biosensors have found numerous applications in various fields such as clinical diagnosis, environmental monitoring, and food safety.

Clinical diagnosis

Optical biosensors have been used for early detection and diagnosis of various diseases such as cancer, infectious diseases, and autoimmune disorders. For example, SPR biosensors have been used for detection of cancer biomarkers such as prostate-specific antigen (PSA) and carcinoembryonic antigen (CEA). Fluorescence biosensors have been used for detection of infectious diseases such as HIV, hepatitis B, and influenza viruses.

CONCLUSION

Optical biosensors have revolutionized the field of biosensing due to their high sensitivity, selectivity, and real-time monitoring capability. They have found numerous applications in clinical diagnosis, environmental monitoring, and food safety. Optical biosensors offer several advantages over traditional detection methods, such as label-free detection, real-time

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monitoring, and the ability to analyze complex samples. As the demand for rapid and accurate detection of biomolecules increases, the development of novel optical biosensors is essential. Future research should focus on improving the sensitivity, specificity, and multiplexing capabilities of optical biosensors. The integration of optical biosensors with microfluidic systems can further enhance their performance and portability. With continuous improvements in optical biosensors, they have the potential to transform the fields of healthcare, environment, and food safety.