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基于胱胺自组装膜和SiO2纳米颗粒增强效应的日本血吸虫压电免疫传感器的研究

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摘　要：

提出了一种基于胱胺自组装膜和SiO2 纳米颗粒增强效应的生物分子固定法，并将之用于日本血吸虫压电免疫传感器的研究。所制备的SiO2 纳米颗粒具有生物亲和性高和比表面积大等优良理化性能，经表面功能化后可高效键合日本血吸虫抗原（SjAg）分子，制得敏化的SjAg@SiO2颗粒。将SjAg@SiO2 固定于修饰了胱胺自组装膜的石英晶体表面，发展了一种新型压电免疫传感器，用于日本血吸虫抗体（SjAb）的检测。实验结果表明，SiO2颗粒的纳米三维（3D）空间结构有利于所固定的抗原对抗体的识别，进而获得了对目标物SjAb的高灵敏检测。所研制的传感器检测感染兔血清样中 SjAb 浓度的线性范围为 0.6 ~ 22.7 μg/mL，检测下限为 0.4 μg/mL（S/N = 3）。此外，临床实际样品的分析结果表明，该免疫传感技术的分析检测能力与经典酶联免疫法（ELISA）相接近，可望用于血吸虫病临床生化诊断、现场筛查和疫情监控等。

关键词：SiO2纳米颗粒；日本血吸虫; 生物分子固定化；压电免疫传感器

A Piezoelectric Schistosoma-Japonicum Immunosensor Based on Self-Assembled Cystamine Film and SiO2 Nanoparticles

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Abstract:

A novel piezoelectric immunosensor for Schistosoma-Japonicum (Sj) has been developed, on the basis of a new biomolecular immobilization matrix using self-assembled cystamine film and SiO2 nanoparticles. The newly prepared SiO2 nanoparticles exhibited excellent physical and chemical properties, such as high surface-to-area and biocompatibility. After the surface functionalization, they were utilized to load Sj antigens (SjAg) at a larger scale. The formed sensitized nanoparticles of SjAg@SiO2 were immobilized onto the sensor that was modified with self-assembled cystamine film, resulting in a new piezoelectric immunosensor for detecting Sj antibodies (SjAb). The results showed that the three-dimensional (3D) spacial structures of SiO2 nanoparticle matrix could facilitate enhanced antigen-antibody immunoreaction, achieving high sensitivity for the detection of SjAb analytes. Under the optimized experimental conditions, the developed piezoelectric immunosensor was proved be capable of quantitatively determining SjAb in the concentration (dilution ratio) range of 0.6 ~ 22.7 μg/mL with a determination limit of 0.4 μg/mL (S/N = 3). Moreover, the new immunoassay was used for the analysis of clinical samples. It could show favorable performances compared to the classical enzyme-linked immunosorbnent assay (ELISA), indicating a promising alternative technique for schistosoma-japonicum in clinical diagnosis, field applications and epidemic situation monitoring.

Keywords: SiO2 nanoparticle; schistosoma-japonicum; biomolecule immobilization; piezoelectric immunosensor

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