Detection of viral pathogens using optical photonic techniques with the aid of selenium nanoparticles

Proceedings of SPIE, Volume 12850, Optical Diagnostics and Sensing XXIV: Toward Point-of-Care Diagnostics

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Viral infections such as HIV and SARS-CoV-2 have significantly increased morbidity in humans and resulted in a significant number of fatalities globally, hence early detection is crucial, particularly at a point-of-care (POC) setting to prevent the spread of these diseases. Localized surface plasmon resonance (LSPR) and green light-based Transmission spectroscopy techniques were used in this study to assess real-time molecular interactions between virus-spiked and non-spiked samples. The current study focuses on integrating selenium nanoparticles (SeNPs) with different optical photonic techniques for enhanced detection of HIV. Selenium nanoparticles were synthesized and functionalized with antibodies specific to HIV. Before and after bioconjugation with viral secondary antibodies, the SeNPs were characterized using Ultraviolet–visible (UV-Vis) spectroscopy, Dynamic light scattering (DLS), High-resolution transmission electron microscopy (HRTEM), and Raman spectroscopy, to elucidate their properties and confirm the presence of functional groups. After that, the NPs were integrated with plasmonic systems and used for the enhanced detection of HIV in comparison to traditional LSPR and Transmission spectroscopy. Colloidal selenium nanoparticles were successfully synthesized, using ND: YAG laser. The orange-colored, spherically shaped nanoparticles were evenly distributed and easily resuspended. Anti-HIV antibodies conjugated to SeNPs were added after HIV-specific antibodies were successfully immobilized on a glass slide substrate to react with HIV pseudovirus. The pseudovirus was effectively identified by the use of Transmission Spectroscopy and LSPR techniques. The two optical techniques for HIV detection were more sensitive after integrating selenium nanoparticles, as compared to the conventional Transmission spectroscopy and LSPR methods. This improved and highly sensitive approach may be utilized to identify viral infections early, thus combating the spread of infectious diseases.