Optical-biosensing of multidrug-resistant Tuberculosis (TB) genes

Proceedings Volume 12840, SPIE BIOS, Optical Interactions with Tissue and Cells XXXV, California, United States, 27 January - 1 February 2024

Chauke, Sipho H
Council for Scientific and Industrial Research (CSIR)
Meiring Naude Drive, Pretoria, 0184
Email: SChauke@csir.co.za

Tuberculosis (TB) remains one of the most important infectious diseases globally, killing approximately 1.5 million people annually. The burden of infection is disproportionately high in low-income and resource-limited settings. This disparity is exacerbated by the emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) Mycobacterium tuberculosis (Mtb), the bacterium that causes TB. Early detection and treatment of TB remain key strategies to reduce the spread and disease progression to drug-resistant forms of TB. However, this is hampered by slow, insensitive diagnostic methods, particularly for the detection of drug-resistant forms and in patients with human immunodeficiency virus infection (HIV). There are currently several rapid TB diagnostics, but most are limited due to costs and accessibility. Several genes, such as catalase-peroxidase (katG) and enoyl reductase (inhA) genes, contain mutations that are responsible for drug resistance. One of the initial objectives of this study was to use an optical-based system to detect katG and inhA genes. Deoxyribonucleic acid (DNA) probes, specific for katG and inhA, were used as biorecognition elements to capture katG and inhA target DNA. The katG and inhA gene-specific DNA probes were immobilized on a coated glass substrate before the target DNA was introduced for detection. As a negative control, a mismatched probe, unspecific to both genes was used for confirmation of the absence of the two genes in the experimental setup. The optical setup was used for the analysis of the binding interactions occurring on the coated glass substrate. The specificity and sensitivity of the coated glass substrate successfully detected the binding interactions through the changes in the transmitted intensity. The transmitted intensity further indicated the kinetics associated with DNA hybridization occurring between the target DNA and the capture probe. This is the initial step to potentially detecting drug-resistant mutations using optical-based biosensors at a point-of-care setting.