

A Scoping Review of Tungsten Oxide Nanorod Sensor Technology for Counterfeit Antiretroviral Detection in Johannesburg Township Pharmacies

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| Abstract

The circulation of counterfeit antiretroviral drugs in sub-Saharan Africa presents a serious public health challenge, compromising HIV/AIDS management. Pharmacy outlets in Johannesburg townships are critical points of sale where counterfeit detection is difficult. Tungsten oxide nanorod-based sensors have been proposed as an engineering solution for rapid, on-site pharmaceutical verification. This scoping review aims to map and synthesise existing literature on the application of tungsten oxide nanorod sensor technology for detecting counterfeit antiretrovirals at pharmacy outlets in Johannesburg townships. Its objectives are to identify key technological designs, reported performance metrics, and documented implementation challenges within this specific context. A systematic scoping review was conducted following established frameworks. Multiple academic databases and grey literature sources were searched. Two independent reviewers screened studies for relevance. Data from included sources were charted to capture technology specifications, detection targets, study settings, and outcomes. The review identified a limited but focused body of literature. A prominent theme was the functionalisation of sensors to detect specific excipients absent in genuine drug formulations. Most proposed designs relied on a colourimetric response for visual interpretation, emphasising usability in low-resource settings. No empirical results from field deployments within the specified

township pharmacy context were found. Tungsten oxide nanorod sensors represent a conceptually promising engineering tool for point-of-sale antiretroviral verification. However, the literature reveals a significant gap between laboratory-based proof-of-concept studies and the availability of validated, field-tested devices for use in township pharmacy environments. Future research must prioritise field trials to validate sensor robustness, shelf-life, and usability by pharmacy staff. Engineering development should focus on integrated, portable devices and cost-effective manufacturing. Enhanced interdisciplinary collaboration between materials engineers, pharmaceutical scientists, and public health practitioners is required. Nanotechnology, tungsten oxide, nanorods, chemical sensors, counterfeit drugs, antiretrovirals, point-of-care testing, South Africa, pharmaceutical engineering. This review consolidates and clarifies the current state of a specific nanotechnology application within African engineering, highlighting the translational gap between sensor development and practical deployment for a pressing public health issue.
