**Novel Biosensors for Rapid Determination of Antimicrobial Resistance (AMR)**

A dynamic, highly sensitive, and compact diagnostic sensor for rapid detection, identification, antibiotic susceptibility and resistance monitoring, in response to the growing market need for diagnostic tools to mitigate antimicrobial resistance.

**Invention Summary:** A research team at Rutgers University has developed a highly sensitive, dynamic, rapid, compact and low cost diagnostic sensor technology for monitoring antimicrobial resistance (AMR) and screening antimicrobials that work against resistant strains. This technology employs magnesium zinc oxide (MZO) nanostructure-modified quartz crystal microbalance (MZO\textsubscript{nano}-QCM) or MZO nanostructure-modified thin film bulk acoustic resonator (MZO\textsubscript{nano}-TFBAR) as biosensors to monitor microbial growth in real-time. MZO nanostructures with controlled surface-wettability, morphology and stability over larger pH range are deposited on QCM/TFBAR top-electrode. Combining advantages of MZO nanostructures with dynamic impedance spectrum capabilities of the QCM/TFBAR makes MZO\textsubscript{nano}-QCM/TFBAR highly sensitive and dynamic, well-suited for AMR detection. Sensitivity of MZO\textsubscript{nano}-QCM and MZO\textsubscript{nano}-TFBAR is \(0.3 \mu \text{g/kHz}\) and \(5 \text{ng/kHz}\), respectively. The Initial characterization of MZO\textsubscript{nano}-QCM shows that it enables to detect the bactericidal effect of ampicillin in *E. coli* within 10 min. In addition, it is also able to detect the growth inhibition effect of miconazole and cytotoxic effect of amphotericin B in yeast within 20-40 min.

**Advantages:**
- Highly sensitive and label-free
- Rapid & real-time monitoring
- High throughput through device arrays
- Low cost & compact
- Capable of wireless connection to personal electronics

**Market Applications:** AMR diagnostic tool/point-of-care diagnostics devices. Research assays. Drug discovery - high throughput screening of antibiotics, antifungal and anticancer agents.

**Intellectual Property:** The core technology has been protected with a PCT application (application no. PCT/US16/52961) filed on 9/21/2016. This PCT application claims priority to three provisional applications filed on 9/21/2015 (application no. 62/221,583), 2/4/2016 (application no. 62/291,231) and 5/24/2016 (application no. 62/340,916), respectively. Furthermore, the related technologies, including the material growth and device fabrication process are covered by the awarded patents.

**Potential Social and Economic Impact:** AMR is a major global-health concern according to the US Center for Disease Control & Prevention (CDC) and the World Health Organization (WHO). In the US alone there are over 2 million people infected with antibiotic-resistant bacteria annually, this is directly responsible for more than 23,000 deaths. Traditional assays available for monitoring bacterial and fungal growth require time-consuming and labor-intensive efforts. There is thus urgent need for developing rapid and highly sensitive tools for diagnosis and surveillance of AMR. The team has invented the magnesium zinc oxide nanostructure-modified quartz crystal microbalance (MZO\textsubscript{nano}-QCM) biosensor to solve this problem. The device is a highly sensitive, dynamic, rapid, compact and low cost diagnostic sensor that non-invasively monitors bacterial cell behavior for antimicrobial susceptibility and resistance testing, including screening antibiotics for activity against resistant strains. The MZO\textsubscript{nano}-QCM measures bacterial cell count and biomechanical properties from its real-time signal spectra. The global clinical microbiology market is projected to reach $5.77 Billion by 2021, at a CAGR of 11.5%, from 2016 to 2021. Key market drivers over the next 10 years for the clinical microbiology industry include technological advancements; rising incidence of antibiotic resistant infectious diseases and growing outbreak of epidemics; and growing healthcare expenditure across the world.

**Next R&D Steps:**
- Optimization of MZO\textsubscript{nano}-QCM through morphology, wettability and Mg composition control.
- Apply the biofunctionalization technology to establish feasibility for drug treatments to pathogenic types of microbial cultures.
- Miniaturize the sensor using MZO\textsubscript{nano}-TFBAR and then integrate it into arrays for high throughput.
- Wireless connection to portable personal system

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