Development of Nano -Transducers for Novel Biosensor Designs

Dr. Evangelyn C. Alocilja
Associate Professor in Biosystems Engineering

Biosensors are analytical devices that integrate biological sensing elements with electronic transducers where the interactions between biological sensing elements and target molecules, proteins, or DNA fragments are directly converted into electronic signal. Biosensors represent a conceptually novel approach to real-time, on-site, and simultaneous detection of multiple biohazardous agents. Samples are minimally processed and they offer rapid testing in the field setting with the option for post-analysis culture in the laboratory. Real-time detection of pathogenic contaminants is critical to the prevention and control of widespread damage from natural or intentional contamination. It provides immediate interactive information about the sample being tested, enabling decision makers to take corrective measures and to quickly recognize impending threats. At the moment, no technology is available that provides field-based real-time diagnosis of pathogenic contamination. Current methods may take 2 to 7 days for confirmation or may require extensive sample preparation.

Highly conductive organic nano-transducers are new and emerging materials for the next generation of biosensor design for highly reliable, stable, and robust field-based diagnostic devices (Abdul-Raouf et al., 1993, CAST 1994, Alocilja and Radke 2002). Dr. Alocilja's research group has been studying and synthesizing conductive polyaniline and polypyrrole as transducer nanomaterials for various biosensor architectures, including antibody-based and DNA-based biosensors. For example,Figure 1 shows a molecular nanowire that is 170 nm wide and 1,000 nm long and Figure 2 shows a polyaniline nanowire bundle.

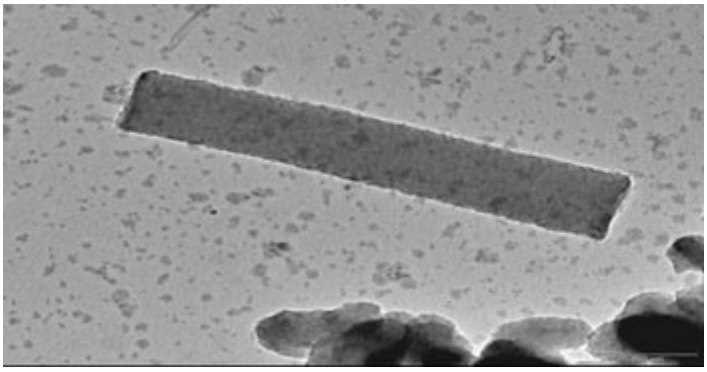

Figure 1. A scanning electron micrograph of a

polyaniline nanowire, 170 nm wide and 1,000 nm long.

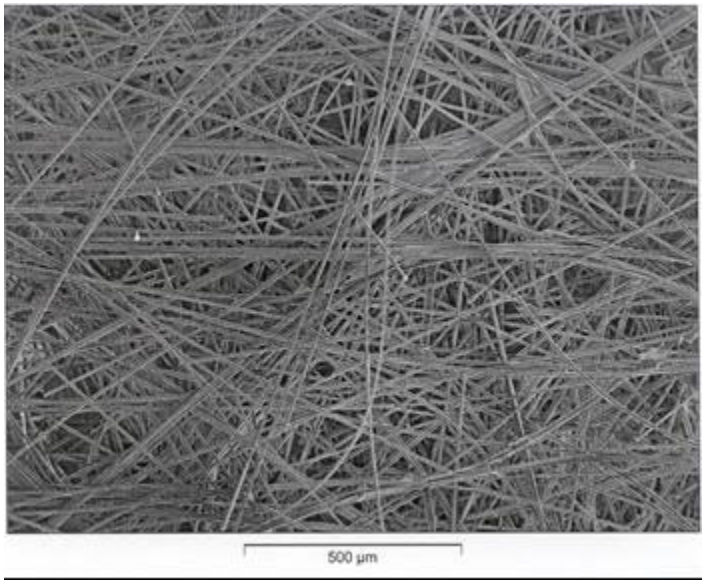

Figure 2. Scanning electron micrograph of a polyaniline nanowire bundle.

For perspective, a human hair is about 50,000 to 100,000 nm wide. Recently, Dr. Alocilja and colleagues (Dr. Mohanty of Packaging and Dr. Tarabara of Civil and Environmental Engineering) received funding from the National Science Foundation to develop a nano-transducer based on the electroconductive polyaniline to be reinforced with single-walled carbon nanotubes (SWNT). Highly improved electrical conductivity of these nano-biosensors will translate into unprecedented sensitivity and will enable design of novel sensing devices for the detection of pathogens and toxins of concern to homeland security, food safety, environmental quality, and public health. It is the hypothesis of this project that increasing the conductivity of polyaniline solution through reinforcement with solubilized SWNT will result in increased signal transduction of the binding event between biological receptors and antigens and will lead to an increase in sensitivity of the nano-biosensor in terms of lower limit and dynamic range of detection. The nano-transducer that will be developed in this project will advance the capabilities of currently designed nano-biosensors for higher sensitivity and speed of detection. These nanomaterials will also contribute to the knowledge base in nanoscale science and engineering for the prevention and protection of our food supply and agricultural operations, and facilitate the improvement of nano-biosensor architectures. These devices will be an additional tool to protect the public from foodborne illness, reduce the health risk of microbial contamination, strengthen food safety measures, and improve bioterrorism surveillance.