Application of Zinc Oxide (ZnO) Nanoparticles for Ruggedized Sensors, and their Integration into a Sensor System

by

Christopher B. Shing

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Approved by the
Examining Committee:

_____
Dr. Shayla Sawyer, Thesis Adviser

_____
Dr. Michael Shur, Member

_____
Dr. Partha S. Dutta, Member

Rensselaer Polytechnic Institute
Troy, New York

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ABSTRACT

ZnO nanoparticles hold promise for use in ruggedized sensing applications where traditional sensors are unable to or incapable of operating under harsh environmental conditions. This factor is primarily due to ZnO is a wide bandgap material. Compared to other wide bandgap materials ZnO has several advantages: it is low cost, can grow on single crystal substrates, and can be wet chemically etched. Additionally, the performance of colloidal ZnO nanoparticles is independent of the substrate onto which they are ultimately deposited.

Throughout fundamental material and device investigations, emphasis was placed on the integration of the resulting novel technology into a system. Specifically, the Sensorcaching project brings our research to the community for the purpose of citizen sensing environmental hazards especially in local waterways. This unique interaction not only affected our community partners but our research goals.

This work is divided into two parts: a study of ZnO nanoparticles created by a top-down wet-chemical etching method for ruggedized sensing and the integration of a detector fabricated from this material into a sensing community. ZnO nanoparticles created by a top-down wet-chemical etching method with polyvinyl-alcohol (PVA) surface passivation exhibit improved optical performance over uncoated ZnO nanoparticles. Elevated temperature measurements on this material show even with passivation the ambient environment affects conduction. Three devices with PVA coated ZnO nanoparticles were fabricated. These devices were used in two applications with potentially harsh operation conditions. Successful results indicate this material holds promise for sensing in these application areas.

A low cost, compact alarm system based on a ZnO nanoparticle detector was created. This biological alarm system was integrated with a community of individuals interested in environmental sensing with the purpose of communicating this new technology to a general audience. An enabling technology, in the form of an open-source microcontroller platform, mobile app, and website, is currently being developed. Total integration of this alarm system with the environmental sensing community is the end objective.