

REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RHB-21-06

ELECTRONIC/ELECTROCHEMICAL/OPTICAL SENSOR FOR MOLECULAR BIOMARKERS

PROJECT DESCRIPTION: The Warfighter Effectiveness Research Center is the research arm of the Department of Behavioral Sciences and Leadership at the United States Air Force Academy, facilitating faculty and cadet research that enhance warfighter effectiveness. The WERC conducts a wide range of research and design projects for operational customers including special operations forces, the Air Force Office of Scientific Research, Air Force Research Laboratory, and Army Research Laboratory. These projects are based in the behavioral sciences and connect to a wide range of disciplines and collaborators across government labs, academia, industry, and military operators in order to generate the most innovative and effective solutions.

Molecular biomarkers indicative of human physiological and psychological status vary both person-to-person and by the measurements point in time. Developing personal chemical and biochemical sensors that enable the profiling/reporting biomarker data throughout an 8-24hr time frame for individual operators will greatly benefit USAF personnel health and performance. Zero footprint, noiseless, and low-powered sensing platforms without the need for calibration and drift correction are highly desirable in development of a wearable or attachable personal sensor suite. Miniaturizing device size and increasing sensitivity and selectivity of chemical/biochemical/optical sensors are key elements in building such sensor suites. In this research, the structural interactions and functionalities of nano device platforms and biomolecule hybrids will be systematically probed by using both experiments and computational modeling. The hybrid system will be further explored for its capability as a sensor for the target of interest. The sample collection, delivery, signal processing, and device-to-device communication for the miniaturized sensors and devices will be explored collaboratively with both internal and external partners.

ACADEMIC LEVEL: Bachelors, Masters, PhD

DISCIPLINE NEEDED:

- Engineering
 - Bioengineering and Biomedical Engineering
 - Chemical Engineering
 - Electrical and Electronic Engineering
 - Material Science Engineering
- Nanotechnology
 - Nanotechnology
- Other Physical Sciences
 - Chemistry (General)

RESEARCH LOCATION: Wright-Patterson AFB Dayton, OH

RESEARCH ADVISER: Steve Kim, PhD
Polymer Science, University of Connecticut, 2007

Dr. Steve Kim serves as a Research Physical Scientist and a Program Manager within the Applied Biotechnology Branch at the 711th Human Performance Wing, Air Force Research Laboratory (AFRL) Wright-Patterson AFB, Dayton OH. Dr. Kim obtained his Ph.D. degree in Polymer Science from the University of Connecticut (2007). After completing National Research Council Postdoctoral Fellow (2007-2010), Dr. Kim continued to work as a contract research scientist at AFRL (2010-2016). Dr. Kim's research interest is developing electronic / electrochemical / optical molecular biomarker and chemical sensors for human performance monitoring and force health protection. Dr. Kim leads research on developing an electronic biosensor platform for trace level cognitive molecular biomarkers, a crucial piece of information to increase the human performance monitoring / assessment capability for the United States Air Force (USAF). Dr. Kim's work focuses on bioreceptors and device platforms that enable miniaturization and wearable electronic and electrochemical biomarker sensing. His pioneering nano material study and analytical strategy have unveiled the governing factors in the Nano-Bio interface. Dr. Kim's current research on volatile organic compound gas sensor development revealed that the nanotube electronic sensor outperforms commercial off the shelf products by integrating an innovative biomimetic chemical receptor for low parts per million (ppm) to sub-ppm level gas target in near zero humidity environment, an equivalency to inhaled air in a high altitude fighter jet. Dr. Kim has authored and coauthored 51 peer-reviewed scientific journal articles including his main-authored AFRL works that were recognized as a "Top20 most read article on the web in a year" and a "Top20 most read article on the web in a month" in a high impact journal, Nano Letters.