Materials Science and Engineering Department

Fall Seminar Series

Molecular Engineering of Field-Effect Transistor Water Sensors Based on 2D Nanomaterials

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The National Academy of Engineering identified "providing access to clean water" as one of the top ten grand challenges for engineering in the 21st century. A central requirement for safe drinking water is the availability of low-cost and real-time water quality monitoring. Current detection methods for critical analytes in water are often too expensive or unsuitable for in-situ and real-time detection. The *unmet need* is evidenced by the insufficient onsite water quality monitoring along the water distribution line and at the point of use that has led to major catastrophes such as the Flint Water Crisis due to the deterioration in water quality within water distribution systems. This talk will unveil a powerful approach to real-time water sensors through molecular engineering of 2D nanomaterials in a field-effect transistor platform. The working principle of the sensor is that the conductivity of 2D nanomaterial channel changes upon binding of chemical or biological species to molecular probes anchored on the nanomaterial surface. As such, the presence and the concentration of analytes (e.g., heavy metals, bacteria, and nutrients) can be determined by measuring the sensor resistance change. The patented technology allows for real-time detection of deadly contaminants with high sensitivity and selectivity in field settings for one-time testing or in-line continuous flow testing. The sensor signals can be wirelessly transmitted to a central control station so that the health status of the entire water distribution system could be monitored remotely in real time. The envisioned smart water distribution system can significantly mitigate risks to ensure a safe water supply. The talk will focus on the molecular engineering aspects of the sensor device (e.g., engineering nanomaterial channel, molecular probe, and device passivation) through both theoretical and experimental approaches. The talk will end with a brief introduction on the translation of the platform technology from concept to prototype product through partnership with industries.

Dr. Junhong Chen is currently Crown Family Professor of Pritzker School of Molecular Engineering at the University of Chicago and Lead Water Strategist & Senior Scientist at Argonne National Laboratory. Prior to coming to Chicago, Dr. Chen served as a program director for the Engineering Research Centers program of the US National Science Foundation (NSF) and the director of NSF Industry-University Cooperative Research Center (I/UCRC) on Water Equipment & Policy (WEP). He founded NanoAffix Science LLC to commercialize real-time water sensors based on 2D nanomaterials. Dr. Chen received his Ph.D. in mechanical engineering from University of Minnesota in 2002 and was a postdoctoral scholar in chemical engineering at California Institute of Technology from 2002 to 2003. His current research focuses on nanomaterial innovation for sustainable energy and environment. Dr. Chen has published over 260 journal papers and has been listed as a highly cited researcher (top 1%) in materials science/cross-field by Clarivate Analytics over the last five years. He is an elected fellow of National Academy of Inventors and the American Society of Mechanical Engineers (ASME).

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