UCSD Jacobs School of Engineering | NANOENGINEERING

Junxin Wang Dissertation Defense
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"Photoacoustic Monitoring in Anticoagulant Therapy"

PI: Dr. Jesse Jokerst

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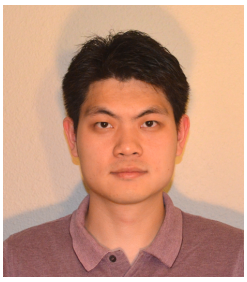

Abstract: Photoacoustic imaging uses nanosecond laser pulses to excite materials and generate acoustic waves. This "light in, sound out" technique can extend the applications of traditional ultrasound by harnessing the optical properties of materials. These features can be used for the non-invasive monitoring of drugs, such as the anticoagulant heparin. Heparin is one of the most common yet unstable anticoagulants in clinics. Heparin medication errors are common because the current gold standard clotting assays have a long turnaround time. This work leverages photoacoustic imaging for heparin and clotting time monitoring via phenothiazine dyes embedded in nanomaterials. The photoacoustic intensity of methylene blue, an FDA-approved dye, was increased 31-fold in human blood upon addition of 10 U/mL heparin, and this signal enhancement was due to the electrostatic association between the two molecules. Furthermore, the signal intensity was correlated to the clotting time (Pearson's $r>0.86$, $R<0.05$), indicating the system's potential as a rapid clotting assay. To translate this technique for clinical use, we developed a cellulose sensor loaded with Nile blue A for finger-prick diagnostics. Human studies using 16 blood samples revealed that the photoacoustic intensity of the sensor was strongly correlated to the accumulative dose of heparin (Pearson's $r=0.71$) and the activated clotting time (Pearson's $r=0.86$). These results demonstrate the capability of photoacoustic imaging for monitoring and maintaining heparin within the therapeutic window in real-time.

Bio: Junxin Wang is a PhD student in the Nanoengineering department at UC San Diego. He received his M.S. degree in Electro-optics from the University of Dayton and a B.S. degree in Optical Information Science and Technology from Changchun University of Science and Technology. His work includes using photoacoustic imaging for therapeutic and cancer monitoring.