University of Louisville
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Literature Seminar

When: 3/3/2022
Time: 12:00 p.m.
Location: CBLL-16

Advancements in fast-scan cyclic voltammetry for improving the detection of small biomolecules

Abstract:
Small biomolecules such as melatonin, dopamine, and adenosine triphosphate (ATP) function as neurotransmitters and important hormones that regulate functions in the brain. To study rapid changes in neurotransmitters, high temporal resolution is required.[1] Fast-scan cyclic voltammetry (FSCV) has become a popular electroanalytical tool to measure neurotransmitters at a fast timescale. However, relatively large charging currents and use of carbon-fiber microelectrodes limits the sensitivity and scope of neurotransmitters that can be measured with FSCV. In this seminar, I will discuss recent advances that have been made to overcome these limitations. First, Ross and coworkers modified the holding potential and scan rate in FSCV to improve the detection limit of melatonin in lymph nodes with a sensitivity of 24 ± 10 nM.[2] Second, Jang and coworkers modified the traditional waveform in FSCV by superimposing a square-wave onto a cyclic, linear potential sweep.[3] This new waveform reduced charging current in the measurement and allowed the authors to reach a dopamine sensitivity of 7 ± 2 nM. The authors also demonstrate how fast cyclic square-wave voltammetry improves the selectivity in electrochemical measurements containing mixtures of neurotransmitters. Third, to expand the scope of neurotransmitters detectable with FSCV, Ross and coworkers electrodeposited Au and Pt nanoparticles (NPs) onto carbon-fiber microelectrodes to catalyze the oxidation of ATP.[4] Au and Pt NP-modified electrodes showed an increase in the sensitivity of ATP oxidation by 4.1 ± 1.0-fold and 3.5 ± 0.3-fold, respectively. Together these advancements push the sensitivity and selectivity of FSCV, enabling measurements of neurotransmitters at low concentrations and in complex environments, an important step to understanding the dynamics in neurochemistry that may prove valuable in studying and diagnosing neurological disorders like Parkinson's and Alzheimer's diseases.

References:
(1) Venton, B. J.; Cao, Q. Fundamentals of Fast-Scan Cyclic Voltammetry for Dopamine Detection. *Analyst* **2020**, *145* (4), 1158–1168. https://doi.org/10.1039/C9AN01586H.
(2) Hensley, A. L.; Colley, A. R.; Ross, A. E. Real-Time Detection of Melatonin Using Fast-Scan Cyclic Voltammetry. *Anal. Chem.* **2018**, *90* (14), 8642–8650. https://doi.org/10.1021/acs.analchem.8b01976.
(3) Park, C.; Oh, Y.; Shin, H.; Kim, J.; Kang, Y.; Sim, J.; Cho, H. U.; Lee, H. K.; Jung, S. J.; Blaha, C. D.; Bennet, K. E.; Heien, M. L.; Lee, K. H.; Kim, I. Y.; Jang, D. P. Fast Cyclic Square-Wave Voltammetry To Enhance Neurotransmitter Selectivity and Sensitivity. *Anal. Chem.* **2018**, *90* (22), 13348–13355. https://doi.org/10.1021/acs.analchem.8b02920.
(4) Li, Y.; Keller, A. L.; Cryan, M. T.; Ross, A. E. Metal Nanoparticle Modified Carbon-Fiber Microelectrodes Enhance Adenosine Triphosphate Surface Interactions with Fast-Scan Cyclic Voltammetry. *ACS Meas. Au* **2021**, acsmeasuresciau.1c00026. https://doi.org/10.1021/acsmeasuresciau.1c00026.