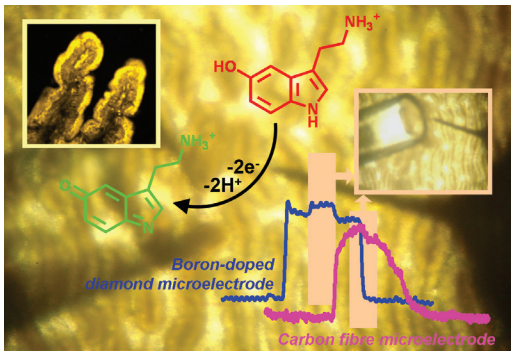
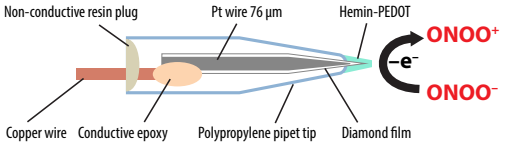
Research in our group is interdisciplinary and spans several fields: physical and analytical electrochemistry, carbon materials, corrosion science and neuroscience. We conduct fundamental research with advanced carbon materials to address key problems and technological needs in energy, health and the environment. Our core science lies in the preparation, processing and application of diamond and diamond-like carbon thin films. We seek to considerably improve the ability to prepare and control the material properties of polycrystalline diamond and nitrogen-incorporated tetrahedral amorphous carbon, and to explore frontier applications where their unique material properties are essential for performance.

Electrochemical Reaction Kinetics and Mechanisms – Factors controlling electron-transfer kinetics and mechanisms at boron-doped diamond and nitrogen-incorporated tetrahedral amorphous carbon thin-film electrodes are being investigated in aqueous, organic and ionic liquid electrolytes. Factors such as the surface chemistry, electrode microstructure and doping level are probed. Electrochemical and spectroelectrochemical measurements are utilized to determine rate constants and mechanisms.

Neuroanalytical Chemistry – In vitro electrochemical, immunohistochemical and neuropharmacological methods are being used to study how neurogenic signaling in the vasculature (ATP and norepinephrine) and the gastrointestinal tract (5-HT and NO) is altered in obesity. These measurements make use of diamond and carbon fiber microelectrodes, and tissues from animal models and humans. The dysfunction in neurogenic signaling is linked to inflammation. Therefore, we are also working on in vitro electrochemical measurements of peroxynitrite (PON); a biomarker of inflammation. The work has important implications for understanding the underlying mechanisms of obesity-linked hypertension and motility disorders.



Electrochemical Sensors for Health – A team of material scientists, chemists, physiologists, microbiologists, veterinary scientists and physicians is developing sensors for electrochemically monitoring biomarkers of wound healing. These smart bandages utilize ink-jet printed electrode technology. There are several biomarkers that are potentially important including pH, oxygen levels and molecules secreted by infectious bacteria such as pyocyanin. We are also working on developing electrochemical sensors for nitric



oxide (NO) and peroxynitrite (PON) that can be used to measure these analytes in exhaled breath and exhaled breath condensate. The sensors utilize a conducting diamond platform that has been chemically functionalized to enable the selective and sensitive detection of each biomarker. We are targeting the sensors for use in respiratory disease management including cystic fibrosis, lung cancer and obliterative bronchiolitis (OB).

Corrosion Protective Coatings and Surface Pretreatments – Research is being conducted to understand how non-chromate coatings and surface pretreatments inhibit corrosion on aerospace aluminum alloys. We study the formation, structure and corrosion resistance afforded by trivalent chromium process coatings and primers on various aluminum alloys (AA2xxx, 6xxx and 7xxx).

Electrochemical methods and surface science techniques are utilized to assess the corrosion status of specimens in the laboratory and during different accelerated degradation tests.

Nanostructured Carbon Powders for Separations and Chemical Sensing – We are preparing high surface area and electrically conducting diamond or diamond/nanocarbon composite powders for use in separations and chemical sensing. The diamond powders are produced by overcoating a substrate powder (diamond, sp2 carbon or metal oxide) with a thin layer of boron-doped ultrananocrystalline diamond. These nanoscale powders offer superb microstructural stability, corrosion resistance and stability over a wide pH range. The conducting and functionalized powders are being developed for use in electrochemically-modulated and reversed-phase liquid chromatography, in diamond paste electrodes for chemical sensing and as an electrocatalyst support for fuel cells.

Greg M. Swain

Physical and Analytical Electrochemistry, Carbon Materials, Corrosion Science and Neuroanalytical Chemistry

Professor
and
Member of the Neuroscience Program
and
The Center for Coatings and Diamond Technologies

(b. 1962)

B.A., 1985,
Univ. of Texas at Dallas;

Ph.D., 1991,
Univ. of Kansas;

Postdoctoral Research Fellow, 1991-92,
Space Power Institute and the
Department of Chemical Engineering,
Auburn Univ.;

JSPS/NSF Postdoctoral Fellow, 1992-93,
Tohoku Univ., Japan;

Assistant Professor, 1994-98,
Associate Professor, 1998-2000,
Utah State Univ.

517-353-1090

Selected Publications

Ionic Liquids. A Unique and Useful Class of Materials, K. Ma, R. Jarošová, Y. Wang, G. M. Swain and G. J. Blanchard, *Chemical Educator* **2018**, *23*, 265-272.

Conductive Diamond: Synthesis, Properties, and Electrochemical Applications, N. Yang, S. Yu, J. V. Macpherson, Y. Einaga, H. Zhao, G. Zhao, G. M. Swain and X. Jiang, *Chemical Society Reviews* **2019**, *48*, 157-204.

Detection of H_2O_2 from the Reduction of Dissolved Oxygen on TCP-Coated AA2024-T3 — Impact on the Transient Formation of Cr(VI), T.K. Shruthi and G.M. Swain, *Journal of the Electrochemical Society* **2019**, *166*, C1-C6.

Inkjet-printed Carbon Nanotube Electrodes for Measuring Pyocyanin and Uric Acid in a Wound Fluid Simulant and Culture Media, R. Jarošová, S.E. McClure, M. Gajda, M. Jović, H.H. Girault, A. Lesch, M. Maiden, C.W. Waters and G.M. Swain, *Analytical Chemistry* **2019**, Article ASAP, *https://doi.org/10.1021/acs.analchem.8b05591*.