James Callis Laboratory

Departments of Chemistry and Bioengineering

Professor Callis is an instrumentation scientist whose major research interests are in the domain of molecular spectroscopy. His lab develops new types of spectroscopic instruments for diverse analytical questions. The group searches for important scientific problems where progress is being limited by the measurement tools currently available. On-going lab projects include (a) the development of new pressure sensitive paints to study insect flight, (b) rapid determination of the wood fiber kappa number of individual fibers using flow imaging, and (c) the development of oxygen sensors to monitor oxygen utilization in islet cells.

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Pressure sensitive paint was developed in the chemistry labs of Martin Gouterman and James Callis in the mid-80s. At present, the paint is used to obtain continuous pressure maps of solid aerodynamic surfaces, such as airfoils and cars. The Callis lab is further developing this technique so it can be used to study unsteady flows over flexible boundaries, e.g. to measure the time dependent surface lift pressure produced by a tethered honey bee in hovering flight. This is a daunting experimental problem because the pressure changes are small and modulated on a time scale on the order of one-tenth of the wing beat cycle. In addition the paint must be biocompatible (i.e. the bee must survive the painting process and be able to fly). New pressure sensitive paints and instrumentation are currently being developed to make these measurements. We hope to accomplish this goal through collaborations with Professor Tom Daniel of the Zoology Department, Dr. John Wettlaufer of the Applied Physics Laboratory, Professor S. Childress at the Courant Institute of Applied Mathematics at New York University. This research is supported by a grant from the National Science Foundation.

Selected Publications

In vivo fluorescence imaging for detection of damage to leaves by fungal phytotoxins, Bower, W. J., Ning, L., Daley, L. S., Strobel, G. A., Edwards, G. E. and Callis, J. B. Spectroscopy, 13, 36-44 (1998).

Five novel applications of imaging visible and short near-infrared spectrophotometry and fluorometry in the plant sciences – Part II: Non-invasive in vivo applications, L. Ning, A. M. Chozinski, A. Azarenko, L. S. Daley, W. J. Bowyer, T. Buban, G. E. Edwards, J. B. Callis, and G. A. Sobel, Spectroscopy, 12, 37-46 (1997).

Quantification of hydrofluoric acid species by chemical-modeling regression of near-infrared spectra, C. J. Thompson, J. D. S. Danielson, and J. B. Callis, Anal. Chem., 69, 25-36 (1997).