Artificially Intelligent Microreactors with In Situ Characterization Methods with Potential Applications in Energy, Chemicals, and Materials

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ABSTRACT The design of novel laboratory flow reactors has the potential to reduce chemical waste, minimize the building space and energy requirements, expedite information, and yield more accurate predictive models during discovery, development, and manufacture. This so-called “process intensification” has merit to revolutionize the science and the engineering of industrial-scale processes. Our laboratory is progressing towards artificially intelligent micro-scale reactors with in situ characterization techniques that can help understand multiphase physical and chemical rate processes. This three-part seminar will summarize our recent reports on i) multiphase microfluidics with in situ Raman spectroscopy designed to probe a reacting liquid-liquid interface, ii) next-generation microsystems designed for applications in the energy and environmental sciences, and iii) the rationale to design artificially intelligent microreactors. Concepts drawn from catalysis in organometallic C-C cross-couplings, and the discovery of reaction mechanisms at immiscible interfaces will be examined. In situ spectroscopic mapping of packed-bed microreactors can also provide broad insight on the occupancy and nanosheet-size distribution of macromolecules such as asphaltenes that are encountered in upstream and downstream energy production. In the other hand, the design of high-pressure, sub-cooled microsystems with spectroscopic methods can reveal useful insight on the transport limitations during the crystallization and dissociation of methane hydrates. Generally speaking, microreactors with online spectroscopic methods create the possibility of artificial neural network control and automation. Their use could accelerate the discovery of new catalysis science. The seminar will conclude with a brief discussion of emerging trends in catalysis and reaction engineering.

BIO Dr. Ryan L. Hartman is an Associate Professor in the Department of Chemical and Biomolecular Engineering at New York University. Prof. Hartman completed his postdoctoral research in the Department of Chemical Engineering at the Massachusetts Institute of Technology (Cambridge), his Ph.D. in Chemical Engineering from the University of Michigan (Ann Arbor), and his B.S. in Chemical Engineering from Michigan Technological University (Houghton). He is the Catalysis and Reaction Engineering Programming Chair of the American Institute of Chemical Engineers. He was recently honored as Visiting Assistant Professor of the Institute of Condensed Matter Chemistry of Bordeaux (ICMCB) CNRS. Previously, Hartman was Assistant Professor and Reichhold-Shumaker Fellow in the Department of Chemical and Biological Engineering at The University of Alabama (Tuscaloosa). He is also a winner of the NSF CAREER Award and member of the National Academy of Inventors. Hartman returned to academia following his private sector career with Schlumberger Limited.