Chemical Reaction Engineering New Tools for Discovery and Development in Flow

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Engineering novel tools for the discovery of science, and translation of the new knowledge from the laboratory to application are societal challenges. Our laboratory helps to address these challenges by applying catalysis and reaction engineering (CRE) principles. By applying CRE principles, we are able to design novel reactors and catalysts for the discovery and the development of chemical methods in flow. Performing chemical reactions in flow (or sometimes referred to as "flow chemistry" in the synthetic chemistry community) has the potential to reduce the amount of chemical waste generated, minimize the building space and energy requirements, expedite information, yield more accurate predictive mathematical models, and enable safer handling of hazardous compounds during scientific discovery, development, and manufacture. This so called "process intensification" has merit to revolutionize the way we currently discover, develop, and manufacture fine chemicals, materials, natural products, and pharmaceuticals that have global markets.

This two-part seminar will commence with a brief overview of the Department of Chemical and Biomolecular Engineering and the Tandon School of Engineering at New York University. The technical content will cover green chemical reaction engineering for kinetics discovery and sustainable manufacturing (Part I) and novel laboratory-scale reactors for the online discovery of multiphase reactions (Part II). In Part I, concepts drawn from catalytic cycles in organometallic C-C bond formation, water as an unconventional reaction solvent, multiphase reaction engineering, and process intensification will be presented. A liquid-liquid Heck alkynylation performed in batch versus continuous-flow will also be evaluated by redefining the *E-factor* in terms of chemical engineering first principles. Part II will examine our recent work on semi-flow microfluidics with *in situ* Raman spectroscopy for liquid-liquid and gas-liquid interfaces. Microsystems in upstream petroleum and natural gas production have tremendous potential for big data with automated feedback from the laboratory to field operations. Studies on soft matter (*e.g.*, asphaltenes) in packed-bed microreactors with *in situ* analytics will also be highlighted. Our understanding of flash crystallizations of gas hydrates with high-pressure sub-cooled microsystems could also someday advance flow assurance and energy storage technology. The seminar will conclude with discussion of emerging trends in catalysis and reaction engineering.

Ryan L. Hartman is Assistant Professor and Faculty Engineer in Residence 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.