Fifth Sivaram Endowment Lecture 2025

Automation in Polymer Synthesis: From Flow to Liquid Handling

by

Professor Tanja Junkers

Monash University,
Australia

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Time: 09:40 am to 10:10 am

Venue: MACRO-2025 at Staudinger Hall
IIT Kharagpur Research Park, Newtown, Kolkata

Organized by:

The Society for Polymer Science, India

Abstract

Chemistry, including the subdomain of chemical synthesis is rapidly adopting modern machine learning (ML) methodologies, as evidenced in many examples ranging from AlphaFold to the introduction of fully robotic laboratories for exploration of chemical spaces. However, in order to harness the power of ML, consistent and standardized data is required in quantity. Traditionally, chemical datasets, especially concerning synthesis of compounds, are fairly small, prohibiting the use of advanced ML algorithms. Thus, it is mandatory to improve data generation first, before more meaningful deep learning methodologies can be applied.

Unfortunately, human operation in a chemical synthesis lab is not only slow, but also prone to human bias and error. Even with skilled operators, synthesis outcomes often are not reproducible, since also glassware and exact reaction conditions are not standardized. A key to overcome these hurdles is the introduction of robotic synthesis. Robots are able to carry out tasks reliably and reproducibly in algorithmic fashion. Yet, the introduction of robotic systems to chemical laboratories is generally slow, due to the high technical implementation hurdle.

In this talk we will discuss what exactly constitutes a robot, and how robotics and automation can be used in everyday tasks efficiently, with an emphasis on simple systems. Specifically, we will look at continuous flow machines and at liquid handlers. The workflow of these relatively simple and quite affordable setups will be discussed, possibilities and challenges identified, and some recent examples given on the example of high throughput polymer synthesis, efficient kinetic screening and generation of libraries of materials. Flow chemistry is particularly suited towards self-driving labs that perform automatic self-optimizations in a closed loop. Liquid handlers, and their massive parallelization of reactions, provide an excellent tool for kinetic screenings and property evaluations. Based on these examples, we will also delve into the prediction of new materials based on ML analysis of the obtained datasets.

About the speaker

Tanja Junkers graduated with a PhD degree in physical chemistry from Goettigen University in Germany in 2006, having worked on the determination of kinetic rate coefficients for radical reactions during polymerizations. In the two years that followed, she was research associate at the University of New South Wales in Sydney, shifting her focus more and more towards synthetic polymer chemistry. Between 2008 and beginning of 2010 she was a senior research scientist at the Karlsruhe Institute of Technology in Germany in the group of Prof. Christopher Barner-Kowollik. Early 2010 she was then appointed professor at Hasselt University in Belgium, where she founded the Polymer Reaction Design group. January 2018 she joined Monash University as full professor, focusing on her work on continuous flow polymerizations, (nano)particle formation and design of complex precision polymers. For the time being, she keeps a guest professor role at Hasselt University until her last PhD students there will have graduated.

Website: https://research.monash.edu/en/persons/tanja-junkers/

About Dr. S. Sivaram

Dr. Sivaram is a polymer chemist, mentor and science manager of distinction. An alumnus of IIT-Kanpur (M.Sc. 1967), he received his Ph. D in Chemistry from Purdue University, W. Lafayette, Indiana, USA in 1971. He was a Research Associate with Professor J. P. Kennedy at the Institute of Polymer Science, the University of Akron, Akron, Ohio during 1971-73. Dr. Sivaram returned to India to begin his scientific career at the Indian Petrochemicals Corporation Limited, Vadodara and moved to National Chemical Laboratory (CSIR-NCL) in 1988 to lead the Polymer Chemistry Division. He later rose to the position of Director NCL from 2002-10. He was a CSIR Bhatnagar Fellow at NCL, Pune (2010-15) and INSA Senior Scientist at the Indian Institute of Science Education and Research (IISER), Pune (2016-19). Currently, he is an Honorary Professor Emeritus and INSA Emeritus Scientist, at IISER, Pune and an Honorary Professor of Chemistry at IISER-Kolkata.

Dr. Sivaram is a recipient of many honours for his scientific contributions. He is an elected fellow of all the learned academies of science and engineering in India. The President of India conferred on him the fourth highest civilian award, Padma Shri, in 2006 in recognition of his contributions to nation building. The Institute of Polymer Science, University of Akron honoured him with the H. A. Morton Distinguished Professorship in 2006. Purdue University conferred on him a degree of Doctor of Science(h.c) in 2010 in recognition of his exceptional merit and attainment. IIT Kanpur bestowed on him the distinguished alumnus award in 1998. He was honoured by the Japan Society of Polymer Science in 2018 with the International Award for his distinguished contributions to polymer science. The Chemical Research Society of India conferred on him its Gold Medal in 2019 for his life-time contributions to chemistry.

Dr. Sivaram is widely recognized for his contributions to polymer science, technology development, institution building and management of innovation in publicly funded organizations. He built a strong research school in polymer chemistry at NCL and brought global visibility, both, from academia and industry, to the activities of his group. He has trained a large number of students who occupy influential positions in India and outside He also played a stellar role in creating the Society of Polymer Science, India (SPSI) and has nurtured it from its very inception to make it a vibrant forum for scientists and students involved with the discipline of Polymer Science in India. Through his myriad activities over five decades, Dr. Sivaram has brought respect to the discipline of polymer science in India, especially, among those practicing chemistry research, enhanced the global visibility for Indian polymer science research and continues to be one of the most visible and influential faces of science in India, in academia, government and industry.

About Sivaram Endowment Lecture

Dr. Sivaram endowment lecture has been instituted by his large family of students, associates, colleagues, mentors and well-wishers, from academia and industry and from within India and outside. The main objective of this lecture is to popularise polymer science and technology in the country and to inspire young researchers working in the area of chemistry, in general, and polymer science, in particular. The lecture shall be held once in two years co-terminus with the biannual MACRO conferences held under the auspices of The Society for Polymer Science, India (SPSI). The lecturer will also be encouraged to visit an educational institution in India to interact with young students. The society will strive to invite distinguished scholars from India and abroad to deliver the endowment lecture. We, his former students and associates, believe that this is the most fitting way to acknowledge the values that Dr. Sivaram taught us, namely, pursuit of excellence and relevance in scientific research and education, high standards of professional integrity and service to the scientific community.

Earlier Speakers

2017 : Professor M. Sawamoto, Kyoto University, Japan.
2018 : Professor Nikos Hadjichristidis, KAUST, Thuwal, Kingdom of Saudi Arabia.
2020 : Professor Richard Hoogenboom, Ghent University, Ghent, Belgium
2023 : Prof. Stefan Mecking, University of Konstanz, Germany