Coating Process Fundamentals Program

Coatings, films, membranes, and interlayers are everywhere. They are commonly made by depositing liquid layers of polymer solution or particulate suspensions, which are then "cured" or solidified by drying, polymerizing, or cross-linking. The solidified layer is a functional coating with microstructure and properties that are essential to its use. Alternatively, the layer can be stripped off the substrate to make a free-standing film that functions on its own as a membrane or layer in a laminated structure such as a fuel cell or membrane. Similarly, printed patterns are created on substrates using processes that involve depositing liquid in small patches followed by solidification.

Coated and printed materials are vital ingredients of an enormous diversity of products from adhesives, coated papers and fabrics, printed graphics, and pre-coated steel and aluminum, to separation membranes, photographic film, magnetic tapes, and flexible electronic devices.

The key technological challenges are to achieve the desired functions of the coating, which may be electrical, optical, photochemical, permselective, catalytic or adhesive, through control of the interfaces and microstructures. This must be commensurate with industrial requirements of a reproducibly uniform or patterned product and, most often, a continuous, high-throughput, efficient manufacturing process capable of rapid changeover. Therefore, one focus of this research program is to deliver, through scientific understanding of liquid flow coating, solidification, and microstructure development, the optimum process conditions for identified industrial needs. The avenues for this work include new processes for advanced materials systems, more efficient processes, improved product quality, and in-line measurement and process control.

A cross-disciplinary approach to the basic challenges facing coating processes is inherently necessary. The Coating Process Fundamentals Program is unique in its comprehension and depth of inquiry. The program draws from extensive input from industry and the expertise of researchers in fluid mechanics, optics, elastohydrodynamics, rheology, transport and reaction phenomena, stress and failure analysis, colloid and interface science, microstructure characterization, polymer science and engineering, ceramic science and engineering, applied mathematics, and scientific computation. Individual researchers work in several disciplines themselves as well as collaborate across disciplines. This environment of scientific and technological challenges coupled with industrial interactions has proved superb for educating research students and getting them and their results into applications.

Principal Investigators and their primary areas of expertise:

Lorraine Francis (Program Leader)	Solidification, Stress Development, Microstructure, Printing
Marcio Carvalho (PUC-Rio)	Fluid Mechanics, Rheology, Numerical Methods
Xiang Cheng	Colloids, Polymers, Rheology, Visualization
Satish Kumar	Transport Phenomena, Interfacial Phenomena, Microfluidics
Alon McCormick	Curing, Thermodynamics and Kinetics, NMR
C. Daniel Frisbie	Printing Processes, Printed Electronics

Associated Investigators: Chris W. Macosko and Michael Tsapatsis

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