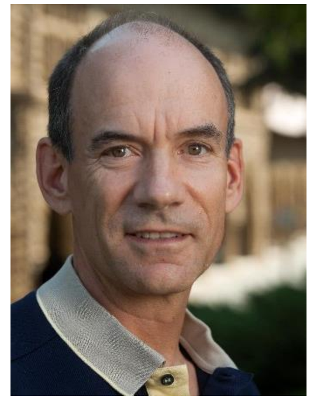
Open-Air Spray Plasma Provides Opportunities for Scalable and Low-Cost Materials and Device Processing: *Understanding Relationships between Structure, Processing and Function*



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He and his research group have worked extensively on integrating new hybrid materials into emerging device, nanoscience and energy technologies and also on the biomechanical function and barrier properties of human skin and other soft tissues. He is an internationally recognized expert on reliability and damage processes in device technologies and soft tissues, specifically the biomechanics of human skin and regeneration processes in cutaneous wounds. He has won numerous awards including the Henry Maso Award from the Society of Cosmetic Chemists for fundamental contributions to skin science (2011), the IBM Shared University Research Award (2011), the Semiconductor Industry Association University Researcher Award (2010), an IBM Faculty Award (2006), the ASM International Silver Medal (2003), an Alexander von Humboldt Research Award (2002), and the U.S. Department of Energy Outstanding Scientific Accomplishment Award (1989).

Abstract: Open-air plasmas provide opportunities for versatile and low-cost materials synthesis and film deposition on large and/or complex shapes in laboratory air and at low temperature. The generally solvent-free process further allows for the simultaneous functionalization of, and deposition on, substrates in a single step. Recent advances in the use of plasma process gasses together with the possibility of combining plasmas with spray deposition have further expanded the utility of the deposition technique for a range of multi-functional films. I discuss the molecular design of such multi-functional films, new methods for processing using plasma processing in air on plastics, and metrologies to characterize the adhesive and degradation processes that are important for reliable application over extended operating lifetimes.

We demonstrate highly efficient deposition methods to deposit multilayer protective coatings on polymer, silicon and glass substrates. We also report on the feasibility of using open air plasma to deposit various conductive and antireflective bilayer films on both silicon and plastics. Finally, we demonstrate a scalable atmospheric plasma process to rapidly deposit and form perovskite cells and modules in open air at fast linear deposition rates. The process uses clean dry air to produce a combination of reactive species, UV and thermal energy to rapidly form the perovskite film after air spraying. Completed perovskite devices were further encapsulated with open-air plasma deposition of dense silica barrier films.