Small Molecule Adsorption on Nano-abrasives used in Chemical-Mechanical Planarization

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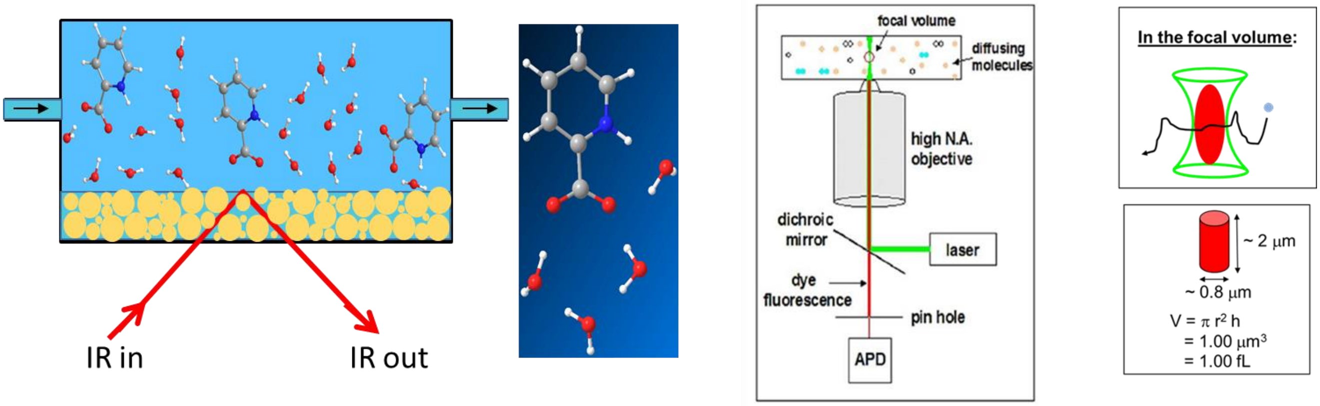
Graphical Abstract



Abstract

Small molecule adsorption on chemical-mechanical planarization (CMP) slurry nano-abrasives has been investigated previously for silica and ceria nano-abrasives using fluorescence correlation spectroscopy (FCS) [**1,2**] and attenuated total reflectance – Fourier transform infrared spectroscopy (ATR-FTIR) [**3**]. The need for continuing characterization of such adsorptive interactions is dictated by the increasing use of nano-abrasives in CMP slurries with reduced hydrodynamic diameters ($\leq$ 10 nm) as a means to minimize surface defects creation during CMP processes. Incorporation of smaller nano-abrasives in CMP slurries will, however, promote the adsorption of small molecule chemical additives due to the increase in the total nano-abrasive particle surface area. The use of FCS and ATR-FTIR in the analysis of small molecule adsorption on alumina and zirconia nano-abrasive particles is described. This work is motivated by the widespread commercial use of alumina-based slurries in CMP processes for planarization of deposited copper films on dielectric layers, and the proposed use of zirconia abrasives in CMP slurries [**4**] for metal film removal on dielectric metal oxide materials. Described FCS studies employ a fluorescent dye as a probe for adsorption sites on alumina and zirconia nano-abrasives dispersed in aqueous solution. Presented ATR-FTIR analyses summarize the characterization of molecular interactions driving glycine and picolinic acid adsorption on porous, thin films of nano-abrasive alumina and zirconia particles, respectively.

Keywords: FCS; ATR-FTIR; adsorption; chemical-mechanical planarization; CMP.

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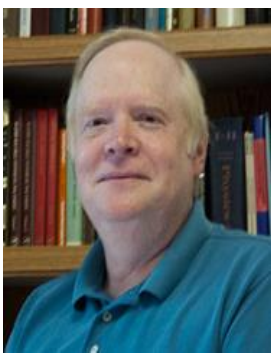
Biography of Presenting Author



Edward E. Remsen received his Bachelor of Science degree in Chemistry from Manhattan College, an M.S. in Chemistry from the Polytechnic Institute of New York, and his Ph.D. in Chemistry from Princeton University. His doctoral research was in the area of resonance Raman spectroscopy of mixed valence compounds and electron transport proteins. After completing his doctoral studies, he joined Monsanto Plastics and Resins Co. in 1979 as a Senior Chemist in the company's Springfield, MA facility. His area of research was the development of analytical techniques supporting new polymer product development. He transferred in 1982 to Monsanto's Corporate Research group in the company's world headquarters St. Louis, MO. His research in Monsanto Corporate Research was the development of new analytical methods for supporting R&D and commercialization of new macromolecular products, including protein drugs. In 1992 he was appointed a Monsanto Fellow. In 2000 he left Monsanto to take a Research Scientist position in the Dept. of Chemistry of Washington University in St. Louis. His research involved analytical and physical chemical studies of organic nanoparticles. In 2003 he took a position with Cabot Microelectronics Corporation in Aurora, IL as a Senior Scientist and Manager of the company's Metrology Group in its R&D and Quality departments. In 2009 he joined Bradley University as an Assistant Professor in the Mund-Lagowski Dept. of Chemistry and Biochemistry. In 2014 he was promoted to Associate Professor, and to Professor in August 2020. His current research includes single-molecule fluorescence spectroscopic studies of mass transport phenomena, small molecule adsorption metal oxide nanoparticles, molecular characterization of adsorptive interactions at the surface of colloids, and physio-chemical studies of nanomaterials designed for medical applications. He has co-authored 98 peer-reviewed publications, is an author and co-author of 43 conference and invited presentations and is a coinventor on 2 patents. In 2017 he received Bradley University's Samuel Rothberg Professional Excellence Award in recognition of his accomplishments in research and scholarship. He teaches the analytical chemistry sequence which includes Analytical Chemistry (CHM 326), Instrumental Analysis (CHM 420/520), and Fundamentals of Separation Science (CHM 524).

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