From Ionic Crystals to Ionic Conductivity: An Iconic Celebration of Gary W. Rubloff's 50+ Years in Science
Room 317 - Session GWR-MoA

From Ionic Crystals to Ionic Conductivity: A Special Celebration of Gary W. Rubloffs 50+ Years in Science II

Moderators: Prof. Parag Banerjee, University of Central Florida, **Prof. Alexander Kozen**, University of Vermont

1:30pm **GWR-MoA-1 Pyridine-Catalyzed Molecular Layer Deposition of Silicon Oxycarbide***, **Gregory Parsons**,* Department of Chemical & Biomolecular Engineering*; Man Hou Vong, Seoyeon Kim, Michael Dickey,* North Carolina State University

Hydrogenated silicon oxycarbide (SiOC-H) is a common low-permittivity dielectric material in integrated circuits. As integrated circuits continue to downsize, SiOC-H deposition processes, such as molecular layer deposition (MLD) that offer precise thickness control and high conformity are increasingly vital. MLD of SiOC-H using bis(trichlorosilyl)methane and water satisfies these demands via self-limiting surface reactions. Herein, we introduce the use of pyridine in the precursor dosing step to catalyze SiOC-H MLD, resulting in a growth per cycle (GPC) of 0.31 nm/cycle, 2x larger than previously reported, and ten times larger than observed under identical conditions without catalyst present. Upon annealing at 250 – 550 °C, the Si–CH_2–Si and Si–OH groups in SiOC-H undergo intramolecular reactions to form terminal Si–CH_3 groups. These Si–CH_3 groups decreases the density and dielectric permittivity (from ~8 to 3.55). Annealing induces a transition in the SiOC-H which enhances its etch resistance against diluted hydrofluoric acid solution. We compare the etch selectivity of as-deposited and annealed SiOC-H with that of silicon dioxide during CHF_3/Ar reactive ion etching. Overall, our findings advance the practicality of SiOC-H MLD for fabrication of nanoelectronics.

1:45pm **GWR-MoA-2 From Micro-Batteries to Nano-Ionics: a Two-Decade Journey with Ionic Thin Films***, **Keith Gregorczyk**,* University of Maryland College Park

Keith Gregorczyk completed his PhD under Gary Rubloff in 2013, followed by a postdoctoral fellowship with Mato Knez at CIC nanoGUNE in San Sebastián, Spain. He returned to the University of Maryland as a Research Scientist, where he spent over 15 years — and more than two decades in total working alongside Prof. Gary Rubloff — developing new scientific directions, designing experimental research programs, and mentoring the next generation of graduate students and post docs.

This talk reflects on the scientific journey that emerged from that collaboration: the integration of thin-film ionic materials into semiconductor device architectures using vapor-phase synthesis techniques, particularly atomic layer deposition (ALD). Materials such as $LiPO_3$, LiPON, lithium titanium phosphate (NASICON), and zirconium phosphate introduce new electrochemical functionality — including Faradaic energy storage, electrochromic switching, and non-volatile tunable electronic and ionic conductivities — into platforms traditionally defined by semiconductor design rules. Critically, many of these functional states are low-energy and non-decaying, making them highly attractive for next-generation device integration.

The talk will trace the arc of this work from foundational studies validating the power-energy relationships predicted by Rolison, Dunn, White, and Long in thin-film lithium solid-state batteries, through the development of solid-state sodium-ion systems, to the emergence of a broader framework for advanced nano-ionics: adding electrochemical functionality to solid-state, semiconductor-manufactured devices. This body of work exemplifies the cross-disciplinary spirit that has defined Prof. Rubloff's career — bridging surface science, thin-film synthesis, and electrochemistry to open new frontiers in functional device design.

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