David M. Stewart

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Professional Summary

I work on thin film energy storage systems and basic materials science, developing micro-batteries for microelectronics applications and to study fundamental battery science. Recently I have been pursuing questions of electrochemical interface formation and kinetics, and stress-electrochemistry coupling. In my spare time, I enjoy teaching physics and nanofabrication skills, mentoring and supporting early career development, and creating physics outreach programs for elementary and middle school students to enhance critical thinking skills and STEM inclusion.

Appointments & Education

University of Maryland, College Park, MD	Assistant Research Scientist	2019 – present
	Post-doctoral Research Assistant	2016 – 2019
University of Maine, Orono ME	**Doctor of Philosophy, Physics**	2016
	Graduate Research Assistant	2013 – 2016
University of Florida, Gainesville, FL	**Bachelor of Science, Physics**	2011

Student Advising & Mentoring

Graduate

Victoria Ferrari	Ph.D. 2024	Interfaces in thin-film solid-state batteries (working title)
Haotian Wang	Ph.D. 2022	Electrochemo-mechanics characterization of Si electrode/Si based solid-state battery
Sam Klueter	M.S. 2020	Investigating Aluminum Nitride as a Protection Layer for Lithium Germanium Thiophosphate Solid Electrolytes

Undergraduate

Saleh Kemal	2022	***NSF REU Student***. Electrochemical characterization of anode-free, thin film solid-state batteries for understanding kinetics of Li plating.
Paolo Lami	2020 – 2022	***Research Student***. Multiphysics finite element analysis of mechanical confinement effects in solid-state batteries and related experiments.
Timothy Blier	2016	***Research Student***. Processing of lattice matched substrates for epitaxial h-BN growth.
Analise Roti-roti	2015	***NSF REU Student***. Processing and characterization of nanolaminate metal films for high temperature sensors.

Teaching

Microprocessing Materials
UMD Dept. of Materials Science & Engineering

Guest Lecturer. Prepared and presented lectures on thin film deposition techniques and processing for microelectronics fabrication, and prepared homework assignments.

Modern Physics
UMe Dept. of Physics & Astronomy

Guest Lecturer. Prepared and presented lectures on modern physics topics such as nuclear radiation, Plank's law, and the discovery of quantum mechanics.

Introductory Physics with Calculus
UMe Dept. of Physics & Astronomy

Teaching Assistant. Lead recitation sections using inquiry-based learning and group discussion, facilitated labs, volunteered tutoring and exam prep after hours.

Research

U. of Maryland
DOE BES

Thin Film Platforms for Interfaces and Mechanical Coupling. Directing several projects with advisees and pursuing others personally and with collaborators, all in the vein of using thin film structures to study fundamental phenomena in batteries.

Advisee projects: electrochemo-mechanical coupling experiments on Si electrodes, revealing the dynamical interactions between lithiation and stress gradients; thin film solid-state battery formation and characterization through a surface science approach, looking at interfacial impedance and interphase formation; modeling mechanical and chemical phenomena in 3D architectures, and effects of deposition conditions and flexible interlayers for stress relief.

Personal projects: formation of thin film devices with artificial grain boundaries to study lithium dendrite propagation; modeling of fields and fluxes in complex 3D battery architectures for informing experiments and projecting device performance at full scale.

Collaborations: studies of band bending at battery interfaces and the impact on Li^+ transport; effects of applied stresses on battery kinetics, thermodynamics, and dendrite growth.

U. of Maryland
DOE EFRC

Nanostructures for Electrical Energy Storage. Developed and characterized ALD thin film electrodes based on SnO_2 as anodes for 3D microbatteries. Found a process to mix SnO_2 and Sn_3N_4 films to produce SnO_xN_y films of varying composition. Thin films had greater reversibility as Li^+ electrodes than bulk examples. Also studied aspects of the manufacturability of different microbattery architectures, and projected performance of various design optimizations.

U. of Maine
NSF DMR

ZrB_2 Thin Films for Harsh, High Temperature Environment Sensors. Thin film samples were deposited by e-beam co-evaporation to obtain different compositions, and the electrical, chemical, crystallographic, and morphological stability was studied under air, vacuum, and inert atmosphere annealing up to 1200 °C. The performance of environmental barriers was also analyzed at these temperatures, including ALD aluminum oxide and sputtered, high crystallinity h-BN coatings. Candidate thin films were used to fabricate piezoelectric sensors on YSZ substrates for high temperature sensors.

U. of Maine
NSF DMR

Hard X-ray Absorption Spectroscopy. Participated in three group visits to NSLS at Brookhaven National Lab, and one solo trip to ALS at Argonne National Lab. XPS and PES of thin film Pt-Si and ZrO_2-ZrB_2 samples was attempted to gauge depth dependance of composition. XANES of ionic liquids for flow batteries and thin film ZrB_2 samples lead to two publications.

U. of Florida
NSF CHE

Silicon Nanoparticles with Silver Adsorbates. Pursued density functional theory calculations on several nanoparticle structures with and without adsorbate clusters and dopants. The goal was to predict photo-absorption and exciton lifetimes for improved solar cell efficiency.

Service

Public Outreach

Physics is Phun and Discovery Days. Developed and lead public shows and interactive demos for local K-12 students and families. Helped develop "Quantum for Kids" program, a four-hour event for elementary and middle school students. Recorded demos on super conductivity for remote classes. 2018 – 2021

Society of Physics Students. Volunteered to tutor undergrad students in all introductory courses weekly and at special exam review sessions. 2014 – 2016

Maine Engineering Week Expo. Performed table demos on crystal structures for K-12 students and families. Gave public tours of surface science labs. 2015

4-H Science Saturday. Prepared an opening talk on nanoscale science and helped with hands on science demos with middle school girls using ACS PCSA Materials Science Kits. 2014

Early Career Development Programs

MRS Career Advancement Committee Member. Leading organization of the "Meet the New Research Hires" poster session for connecting early career scientists with jobs in national labs and companies. Hosted a panel webinar on the faculty application process. 2020 – present

DOE Early Career Network Representative. Lead discussion groups on mentoring and public outreach. Supported organization of webinars on tenure, proposal writing, and research at national labs. 2018 – 2020

Publications

Y. Song, B. Bhargava, D.M. Stewart, A.A. Talin, G.W. Rubloff, P. Albertus. "Status of and opportunities in electrochemical–mechanical coupling measurements." *Joule* **7**, 1-23 (2023). DOI: 10.1016/j.joule.2023.03.001

(accepted) Z. Levy, V.C. Ferrari, P. Rosas, M. Walker, K. Duddella, H. Kalpak, M. Haseman, D.M. Stewart, G.W. Rubloff, L.J. Brillson. "Lithium Spatial Distribution and Split-off Electronic Bands at Nanoscale V2O5/LiPON Interfaces." *ACS Advanced Energy Materials*, **XX**, X, XXXX (2023). DOI: 10.1021/acsaem.2c03683

H. Wang, N.S. Kim, Y. Song, P. Albertus, S.B. Lee, G.W. Rubloff, D.M. Stewart. "Micro-Raman Stress Characterization of Crystalline Si as a Function of the Lithiation State." *ACS Applied Materials & Interfaces*, **15**, 8, 10752–60 (2023). DOI: 10.1021/acsami.2c22530

D. Fontecha, R.B. Nuwayhid, A.C. Kozen, D.M. Stewart, G.W. Rubloff, K.E. Gregorczyk. "Low temperature plasma-enhanced atomic layer deposition of sodium phosphorus oxynitride with tunable nitrogen content." *Journal of Vacuum Science & Technology A*, **40**, 3, 032403 (2022). DOI: 10.1116/6.0001752

V.C. Ferrari, N.S. Kim, S.B. Lee, G.W. Rubloff, D.M. Stewart. "Co-sputtering of lithium vanadium oxide thin films with variable lithium content to enable advanced solid-state batteries." *Journal of Materials Chemistry A*, **10**, 23, 12518–31 (2022). DOI: 10.1039/D2TA01021F

A. Jarry, S. Ricote, A. Geller, C. Pellegrinelli, X. Zhang, D.M. Stewart, I. Takeuchi, E. Wachsman, E.J. Crumlin, B. Eichhorn. "Assessing Substitution Effects on Surface Chemistry by in Situ Ambient Pressure X-ray Photoelectron Spectroscopy on Perovskite Thin Films, $BaCe_xZr_{0.9-x}Y_{0.1}O_{2.95}$ (x = 0; 0.2; 0.9)." *ACS Applied Materials & Interfaces*, **10**, 43, 37661–70 (2018). DOI: 10.1021/acsami.8b12546

D.M. Stewart, A.J. Pearse, N.H. Kim, E.J. Fuller, A.A. Talin, K.E. Gregorczyck, S.B. Lee, G.W. Rubloff. "Tin Oxynitride Anodes by Atomic Layer Deposition for Solid State Batteries." *Chemistry of Materials*, **30**, 8, 2526–34 (2018). DOI: 10.1021/acs.chemmater.7b04666

A.J. Pearse, T.E. Schmitt, E. Sahadeo, D.M. Stewart, A.C. Kozen, K. Gerasopoulos, A.A. Talin, S.B. Lee, G. Rubloff, K.E. Gregorczyk. "Three-Dimensional Solid-State Lithium-Ion Batteries Fabricated Via Conformal Vapor-Phase Chemistry." *ACS Nano,* **12**, 5, 4286–94 (2018). DOI: 10.1021/acsnano.7b08751

D.M. Stewart, and R.J. Lad. "Enhanced Crystallinity of h-BN Films Induced by Substrate Bias During Magnetron Sputtering." *Phys. Stat. Sol. B: Basic Solid State Physics*, **255**, 1700458 (2017). DOI: 10.1002/pssb.201700458

D.M. Stewart, G.P. Bernhardt, R.J. Lad. "Zirconium Diboride Thin Films for Use in High Temperature Sensors and MEMS Devices." *Proc. SPIE Microtech,* **10246 ©** SPIE (2016). DOI: 10.1117/12.2266561

D.M. Stewart, R.W. Meulenberg, and R.J. Lad. "Nanostructure and bonding in zirconium diboride thin films studied by X-ray spectroscopy." *Thin Solid Films*, **596**, 155–159 (2015). DOI: 10.1016/j.tsf.2015.06.063

C.A. Apblett, D.M. Stewart, R.T. Fryer, J.C. Sell, H.D. III Pratt, T.M. Anderson, and R.W. Meulenberg. "*In situ* XANES and EXAFS analysis of redox active Fe center ionic liquids." *Electrochimica Acta*, **185**, 156–61 (2015). DOI: 10.1016/j.electacta.2015.09.093

R.J. Lad, D.M. Stewart, R.T. Fryer, J.C. Sell, D.J. Frankel, G.P. Bernhardt, R.W. Meulenberg. "Electrically Conductive Pt-Zr-B and Pt-Si Thin Films for Use in High Temperature Harsh Environments." *Mat. Res. Soc. Symp. Proc.* **1746** © Materials Research Society (2015).

D.M. Stewart, D.J. Frankel, and R.J. Lad. "Growth, structure, and high temperature stability of zirconium diboride thin films." *J. Vac. Sci. Tech. A*, **33**, 031505 (2015). DOI: 10.1116/1.4916565

J.C. Sell, D.M. Stewart, G.P. Bernhardt, D.J. Frankel, and R.J. Lad. "Electrically stable nanocomposite thin films formed by oxidation of Pt-ZrB_2 nanolaminate templates." *J. Vac. Sci. Tech. B*, **33**, 021805 (2015). DOI: 10.1116/1.4914313

D.M. Stewart, M.G. Mavros, and D.A. Micha. "Light Absorption by Crystalline and Amorphous Silicon Quantum Dots with Silver Adsorbates and Dopants." *J. Phys. Chem. C.* **116**, 23107–12 (2012). DOI: 10.1021/jp3075805

Presentations

SPIE OP106 (invited)	"Platforms for characterizing thin film electrochemical energy storage devices," D.M. Stewart, V.C. Ferrari, H. Wang, G.W. Rubloff.	2023
242nd ECS Meeting (invited)	"Multi-Scale Electrochemo-Mechanical Experiments on Thin Film Battery Materials," Y. Song, B. Bhargava, Z. Warecki, D.M. Stewart, P. Albertus.	2022
MRS Spring Meeting	"Thin-Film Battery Architecture Approaches for High Power and Energy," D.M. Stewart, R.B. Nuwayhid, K.E. Gregorczyk, A.J. Jarry, G.W. Rubloff.	2019
ECS AIMES (invited)	"Conformal Energy Storage: Atomic Layer Deposition of 3D Solid State Batteries," A.J. Pearse, K.E. Gregorczyk, D.M. Stewart, G.W. Rubloff	2018
AVS 64th Symposium	"Synthesis and Characterization of All Solid-State SnO_xN_y/LiPON/Li Batteries," D.M. Stewart, A.J. Pearse, K.E. Gregorczyck, G.W. Rubloff.	2017
232nd ECS Meeting	"Exploring Electrochemical Energy Storage of SnO2, Sn_3N_4, and SnO_xN_y through ALD," D.M. Stewart, A.J. Pearse, K.E. Gregorczyck, G.W. Rubloff.	2017
MRS Spring Meeting	"ZrB_2 and h-BN Composite Thin Films for Use in Harsh Environments Above 1000 °C," D.M. Stewart, J.C. Sell, R.W.Meulenberg, and R.J. Lad.	2016
APS March Meeting	"Synthesis and Oxidation Resistance of h-BN Thin Films," D.M. Stewart, R.W. Meulenberg, and R.J Lad.	2016
ICMCTF	"Growth and Nanostructure of Zirconium Diboride Thin Films for High Temperature Electronics," D.M. Stewart, R.W. Meulenberg, and R.J. Lad.	2015
AVS 61st Symposium	"Growth and Phase Stability of Zirconium Diboride Thin Films," D.M. Stewart, D.J. Frankel, and R.J. Lad	2014