(Most Significant Impactful Peer-Reviewed Publications/Patents of Historical Significance)

(1) Tran, J.T., K.J. Warren, C. Wilson, L Taylor, R.L. Anderson, D. Mejic, and A.W. Weimer,, "Feasibility of Continuous Water and Carbon Dioxide Splitting via a Pressure-Swing, Isothermal Redox Cycle Using Iron Aluminates" Chemical Engineering Journal, https://doi.org/10.1016/j.cej.2024.154791 (2024). First paper to demonstrate continuous simultaneous redox producing both CO_2 and H_2 in a continuous process for iron aluminate active materials.

(2) Nguyen, J.A., A.Becker, K.Kanhaiya, H. Heinz, and A.W. Weimer, "Analyzing the LiAlO Interphase of Atomic Layer Deposited Al2O3 Films on Layered Oxide Cathodes Using Atomistic Simulations, ACS Applied Materials & Interfaces, https://doi.org/10.1021/acsami.3c15080 16 (1), 1861-1875 (2023). Molecular dynamics used for the first time to understand why a small number of ALD cycles of alumina on cathode particles has such of a dramatic impact on LI-io battery performance

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(3) Tran, J., K.J. Warren, D. Mejic, R.L. Anderson, L. Jones, D.S. Hauschulz, C. Wilson and A.W. Weimer, "Pressure-enhanced performance of metal oxides for thermochemical water and carbon dioxide splitting," Joule, 7, 1759-1768 https://doi.org/10.1016/j.joule.2023.07.016 (2023). Demonstrates for the first time that applying pressure to the oxidation step of an open-loop redox reaction system can increase productivity and reaction rate for an isothermal thermochemical process. Productivity using iron aluminate demonstrated as 10X that of benchmark ceria under isothermal conditions.

(4) Hartig, J., V. Dahanayakeb, J. Nguyen, C. Wilson, A.M. Barnes, and A.W. Weimer, "A moving porous media model for continuous spatial particle ALD," Powder Technology, https://doi.org/10.1016/j.powtec.2023.118448 (2023). Development of a porous media model for the continuous spatial ALD process using directional vibration. This is the commercial process utilized for ALD coating of cathode battery materials.

(5) Weimer, A.W., "From a Laboratory Curiosity to a Commercial Powder Processing Plant – A Personal Perspective," Powder Technology, https://doi.org/10.1016/j.powtec.2023.118279 , 418, March, 118279 (2023). This paper describes the path to commercialization of the rapid carbothermal reduction (RCR) process for producing submicron sized non-oxide ceramic powders and Particle ALD for functionalizing fine powders by atomic layer deposition. Both processes were unique and overcame major hurdles from lab curiosities to commercial processes.

(6) Warren, K.J., J.T. Tran, and A.W. Weimer, "A Thermochemical Study of Iron Aluminate-Based Materials: A Preferred Class for Isothermal Water Splitting," Energy & Environmental Science DOI: 10.1039/d1ee02679h, (2022). First detailed investigation of iron aluminate materials thermodynamics for water splitting.

(7) Lai, A., H. Loehde-Woolard, W.W. McNeary, J. Burger, R. Pfeffer, and A.W. Weimer, "Amine-functionalized Fumed Silica for CO_2 Capture through Particle Molecular Layer Deposition," Chemical Engineering Science, (https://doi.org/10.1016/j.ces.2021.116954) (2021). First demonstration of Particle MLD for depositing amine functional groups for CO_2 capture.

(8) Millican, S.L., I. Androshchuk, J.T. Tran, R.M. Trottier, A. Bayon, Y. Al Salik, H. Idriss, C.B. Musgrave, and A.W. Weimer, "Oxidation Kinetics of Hercynite Spinels for Solar Thermochemical Fuel Production," Chemical Engineering Journal, Article 126015 (2020). https://doi.org/10.1016/j.cej.2020.126015 (2020). First detailed study of the oxidation kinetics for CO2 splitting using iron aluminate active materials.

(9) Al-Shankiti, I.A., A. Bayon, and A.W. Weimer, "Reduction Kinetics of Hercynite redox Materials for Solar Thermochemical Water Splitting," Chemical Engineering Journal, Article 124429 (2020). https://doi.org/10.1016/j.cej.2020.124429 (2020). First detailed study of the reduction kinetics for iron aluminate materials used for CO_2 and water splitting.

(10) Chubukov, B.A., S.C. Rowe, A.W. Palumbo, M.A. Wallace, and A.W. Weimer, "Investigation of continuous carbothermal reduction of magnesia by magnesium vapor condensation onto a moving bed of solid particles," Powder Technology (doi.org/10.1016/j.powtec.2019.01.067), 365, 2-11 (2020). First study to demonstrate condensation of Mg vapor onto a moving bed of solids for Mg capture.

(11) Randolph, T.W., R. Garcea, and Alan W. Weimer, "Compositions and methods for making and using thermostable immunogenic formulations with increased compatibility of use as vaccines against one or more pathogens," U.S. Patent 10,751,408 (2020) and U.S. Patent 11,364,293 (2022).

(12) Arifin, D., A. Ambrosini, S.A. Wilson, B. Manda, C.L. Muhich, and A.W. Weimer, "Investigation of Zr, Gd/Zr, and Pr/Zr – doped Ceria for the redox splitting of water," International Journal of Hydrogen Energy, (https://doi.org/10.1016/j.ijhydene.2019.10.177); 45, 160-174 (2020). Detailed study of the investigation of doped ceria for thermochemical water splitting.

(13) Hoskins, A.L., S.L. Millican, T.A. Gossett, Y. Gao, X.H. Liang, C.B. Musgrave, and A.W. Weimer, "Non-uniform Growth of Ultra-thin ALD films on Lithium Metal Oxide Materials," (submitted, 2019). First paper to elucidate the true nature of low-cycle number ALD films on Li-ion battery cathode materials; films are shown to not be continuous or uniform. Hoskins, A.L., S.L. Millican, T.A. Gossett, Y. Gao, X.H. Liang, C.B. Musgrave, and A.W. Weimer, "Non-uniform Growth of Ultra-thin ALD films on Lithium Metal Oxide Materials," (submitted, 2019). First paper to elucidate the true nature of low-cycle number ALD films on Li-ion battery cathode materials; films are shown to not be continuous or uniform.

(14) Hoskins, A.L., S.L. Millican, C.E. Czernik, J.C. Netter, T.J. Wendelin, C.B. Musgrave, and A.W. Weimer, "Continuous On-sun Solar Thermochemical Hydrogen Production via an Isothermal redox Cycle," (submitted, 2019). First continuous demonstration of on-sun isothermal redox water splitting to produce renewable H_2, using a 10 kW pilot plant facility.

(15) O'Toole R.J., C.J. Bartel, M.U. Kodas, A.J. Horrell, S. Ricote, N.P. Sullivan, C.J. Gump, C.B. Musgrave, and A.W. Weimer, "Particle Atomic Layer Deposition of Alumina for Sintering Yttria-stabilized Cubic Zirconia," Journal of the American Ceramic Society (DOI: 10.1111/jace.16091, 2018). First paper to demonstrate that one Particle ALD cycle enhanced ionic conductivity of YSZ by 23% after sintering at 1350^{o}C for 2 hr; hence, dense parts with high O-ionic conductivity can be produced after sintering at reduced temperatures.

(16) McNeary, W.W., C. Ngo, A.E. Linico, J.W. Zack, A.M. Roman, K.M. Hurst, S.M. Alia, J. W. Medlin, S. Pylypenko, B.S. Pivovar, and A.W. Weimer, "Extended Thin Film Electrocatalyst Structures via Pt Atomic Layer Deposition," ACS Applied Nano Materials 1, 6150-6158 (2018). First paper to demonstrate use of particle ALD for extended surface nanowire fuel cell catalysis.

(17) Rowe, S.C., M.A. Wallace, A. Lewandowski, R.P. Fisher, W.R. Cravey, D.E. Clough, I. Hischier, and A.W. Weimer, "Experimental Evidence of an Observer Effect in High-Flux Solar Simulators," Solar Energy, 158, 889-897 (2017). First paper to demonstrate experimentally that an

observer effect exists for high flux solar simulators (HFSS), confirmed experimentally through use of a cylindrical calorimeter with interchangeable faceplates.

(18) Chubukov, B.A., A.W. Palumbo, S.C. Rowe, I. Hischier, A.J. Groehn, and A.W. Weimer "Pressure Dependent Kinetics of Magnesium Oxide Carbothermal Reduction," Thermochimica Acta, 636, 23-32 (2016). First kinetic study for carbothermal reduction of MgO to account for both temperature and pressure (1350 to 1650 ^{o}C and pressure from 0.1 to 100 kPa), included in the development of a reaction mechanism and reaction rate expression for extreme experimental conditions.

(19) Van Norman, S.A., J.W. Tringe, J.D. Sain, R. Yang, J.L. Falconer, and A.W. Weimer, "Using Atomic Layer Deposited Tungsten to Increase Thermal Conductivity of a Packed Bed," Applied Physics Letters, 106, Article Number 153102 (2015); and "Catalyst, Structures, Reactors, and Methods of Forming Same," U.S. Patent 11,426,717 (2022); U.S. Patent 11,975,314 (2024). Composition of matter for depositing porous highly conductive films.

(20) C. L. Muhich, B. W. Evanko, K. C. Weston, P. Lichty, X. H. Liang, J. Martinek, and A. W. Weimer, "Efficient Generation of H_2 by Splitting Water with an Isothermal Redox Cycle," Science, 341, 540-542 (2013); "a ground-breaking study of fundamental significance because it experimentally demonstrates the feasibility of operating thermochemical redox cycles under isothermal conditions" – C&EN (August 5, 2013; page 9).

(21) A. W. Palumbo, E. L. Jorgenson, J. C. Sorli, and A. W. Weimer, "Co-processing Methane in High Temperature Steam Gasification of Biomass," Bioresource Technology, 128, 553-559 (2013); demonstrated theoretically (validated experimentally) that additive methane can be reacted at high temperatures with biomass/steam to produce a tar free syngas having a molar $H_2/CO = 2$ ratio suitable for liquid fuel synthesis - without requiring downstream water gas shift (hence, no CO_2 is formed in the process and all biomass carbon is converted to syngas CO); also U.S. Patent 8,287,610.

(22) V. J. Aston, B. W. Evanko, and A. W. Weimer, "Investigation of Novel Mixed Metal Ferrites for Pure H_2 and CO_2 Production Using Chemical Looping," International Journal of Hydrogen Energy, 38 (22), 9085-9096 (2013); while typical chemical looping processes involve combustion and generate heat as the primary product, the mixed metal ferrite system experimentally shown here has pure H_2 as the primary product – thus providing for a process in which syngas produces a pure H_2 product stream and a pure CO_2 sequestration stream.

(23) C.L. Muhich, Y. Zhou, A. M. Holder, A. W. Weimer, and C. M. Musgrave, "Effect of Surface Deposited Pt on the Photoactivity of TiO_2," Journal of Physical Chemistry C, 116, 10138-10149 (2012); fundamental understanding that the initial rise and subsequent fall in TiO_2's photoactivity with Pt loading (see paper 12 below) results from the competition between enhanced electron scavenging due to increased O_2 adsorption and increased electron-hole recombination.

(24) X. H. Liang, N.-H. Li, and A. W. Weimer, "Template-directed Synthesis of Porous Alumina Particles with Precise Wall Thickness Control via Atomic Layer Deposition," Microporous and Mesoporous Materials, 149, 106-110 (2012); a new method to simultaneously prepare large pore size, high pore volume mesoporous ceramic structures having nanothick wall thickness that can be controlled to within angstroms. Also, U.S. Patent 10,138,169 (2018), "Highly porous ceramic material and method of using and forming same."

(25) Liang, X.H., J. Li, M.Yu, C.H. McMurray, J.L. Falconer, and A.W. Weimer, "Stabilization of Supported Metal Nanoparticles Using an Ultrathin Porous Shell," ACS Catalysis, 1,

1162-1165 (2011); first paper to demonstrate that a porous film prepared by ALD/MLD can inhibit sintering of nano-metal catalyst particles, thus reducing/preventing catalyst deactivation.

(26) Y. Zhou, D. M. King, X. H. Liang, J. Li and A. W. Weimer, "Optimal Preparation of Pt/TiO_2 Photocatalysts Using Atomic Layer Deposition," Applied Catalysis B – Environmental, 101, 54-60 (2010); demonstrated that only one ALD cycle for Pt deposition increased catalytic photoactivity of crystalline TiO_2 by 3 times; the highest activity Pt/TiO_2 photocatalyst ever reported.

(27) J. R. Scheffe, J. Li, and A. W. Weimer, "A Spinel Ferrite/Hercynite Water-Splitting Redox Cycle," International Journal of Hydrogen Energy, 35, 3333-3340 (2010); a new two-step water splitting "hercynite" cycle for solarthermal conversion providing for significant H_2 production at reduction temperatures ~150^{o}C below conventional ferrite/ceria-based methods; enabled discoveries published in Science paper (see paper (6) above).

(28) X. H. Liang, M. Yu, J. Li, Y.-B. Jiang, and A. W. Weimer, "Ultra-thin Microporous/Mesoporous Metal Oxide Films Prepared by Molecular Layer Deposition (MLD)," Chemical Communications 7140-7142 (2009); a > 1000 m^2/g nanothick film of an oxide placed conformally on the surface of primary fine particles where both the film thickness and the pore diameter can be controlled to within angstroms. Enabling technology for preventing the sintering of nano-catalytic metal particles deposited on high surface area supports, and potentially for controlling reaction selectivity via pore size control. Also, U.S. Patent 9,090,971 (2015), "Ultra-thin metal oxide and carbon-metal oxide films prepared by atomic layer deposition (ALD).

(29) D. M. King, S. I. Johnson, J. Li, X. Du, X. H. Liang, and A. W. Weimer, "Atomic Layer Deposition of Quantum-confined ZnO Nanostructures," Nanotechnology, 20 (19), 195401 (2009); cover article; first demonstration of 3D quantum confinement on particles, used for surface band gap modification.

(30) X. H. Liang, D. M. King, P. Li, S. M. George, and A. W. Weimer, "Nanocoating Hybrid Polymer Films on Large Quantities of Cohesive Nanoparticles by Molecular Layer Deposition," AIChE Journal, 55 (4), 1030-1038 (2009); demonstrated placing nanothick hybrid organic/inorganic films on primary particles using easily scaled-up process equipment.

(31) M. A. Weimer, M. D. Groner, X. H. Liang, D. M. King, L. F. Hakim, P. Li, S. M. George, and A. W. Weimer, "Ultrafast Metal-Insulator Varistors Based on Tunable Al_2O_3 Tunnel Junctions, " Applied Physics Letters, 92, 164101 (2008); quantum tunneling signature electrical surge protection devices with response times measured of <300 picoseconds; also U.S. Patent 7,132,697, "Nanomaterials for Quantum Tunneling Varistors".

(32) L. F. Hakim, C. L. Vaughn, H. J. Dunsheath, C. S. Carney, X. H. Liang, and A. W. Weimer, "Synthesis of Oxidation-resistant Metal Nanoparticles via Atomic Layer Deposition," Nanotechnology, 18, 345603 (2007); method to functionalize the surface of metallic nanoparticles in-situ with nm thick films prior to atmosphere exposure.

(33) L. F. Hakim, D. M. King, Y. Zhou, C. J. Gump, S. M. George, and A. W. Weimer, "Nanoparticle Coating for Advanced Optical, Mechanical and Rheological Properties," Advanced Functional Materials, 17, 3175-3181 (2007); near-perfect nanofilms to modify optical, mechanical and rheological properties of nanoparticles for unique applications including phosphor additives to LEDs; also U.S. Patent 8,163,336, "Methods for Producing Coated Phosphors and Host Material Particles Using Atomic Layer Deposition Methods,".

(34) D. M. King, J. A. Spencer II, X. H. Liang, L. F. Hakim, and A. W. Weimer, "Atomic Layer Deposition on Particles Using a Fluidized Bed Reactor with In-situ Mass Spectrometry, Surface & Coatings Technology 201, 9163-9171 (2007); methodology for controlling fluidized bed reactors operating under reduced pressure for the surface ALD functionalization of ultrafine particles at large scale.

(35) L. F. Hakim, S. M. George, and A. W. Weimer, "Nanocoating Individual Silica Nanoparticles by Atomic Layer Deposition in a Fluidized Bed Reactor," Chemical Vapor Deposition, 11,420-425 (2005); and Hakim, L.F., S.M. George, and A.W. Weimer, "Conformal Nanocoating of Zirconia Nanoparticles by ALD in a Fluidized Bed Reactor," Nanotechnology, 16, S375-385 (2005). First demonstration of the coating of nanothick films on primary nanoparticles for large engineering scale methods; these papers provided the basis for Dr. Luis Hakim receiving the Best PhD Award in Particle Technology (AIChE) worldwide in 2009.

(36) Hakim, L.F., J.L. Portman, M.D. Casper, and A.W. Weimer, "Aggregation Behavior of Nanoparticles in Fluidized Beds," Powder Technology, 160 (3), 149-160 (2005). Introduces concept of "dynamic aggregation", explaining how fluidized aggregates of nanoparticles dynamically shed particles to one another and in the process exposing all surfaces to gases – thus helping to explain how primary nanoparticles can be coated individually and conformally by atomic layer deposition without agglomeration.

(37) J. D. Ferguson, A. W. Weimer, and S. M. George, "Atomic Layer Deposition of Al_2O_3 Films on Polyethylene Particles," Chemistry of Materials, 16 (26), 5602-5609 (2004); Also, U.S. Patent 9,376,750 (2016), "Method of depositing an inorganic film on an organic polymer," first demonstration of the ALD coating of primary polymer particles with uniform nanothick ceramic films; also, first demonstration of an ALD coating on a polymer film not having reactive functional groups.

(38) Wank, J.R., George, S.M., and A.W. Weimer, "Nanocoating Individual Cohesive Boron Nitride Particles in a Fluidized Bed by ALD," Powder Technology, 142 (1), 59-69 (2004). First demonstration of Particle ALD using a scalable agitated fluidized bed reactor – commercially significant.

(39) U.S. Patent 6,613,383 (2003), "Atomic Layer Controlled Deposition on Particle Surfaces;" also U.S. Patent 6,713,177 (2004) and U.S.Patent 6,913,827 (2005). A suite of broad-based patents licensed to ALD NanoSolutions forming IP platform for Particle ALD technology. (Basis for 2004 R&D 100 Award and founding of ALD NanoSolutions, Inc. www.aldnanosolutions.com).

(40) J. D. Ferguson, A. W. Weimer, and S. M. George, "Atomic Layer Deposition of Ultrathin and Comformal Al_2O_3 Films on BN Particles," Thin Solid Films, 371, 95-104 (2000); first reported Particle ALD demonstration , i.e. placing a nanothick ALD film on a primary fine particle.

(41) A. W. Weimer, W. G. Moore, R .P. Roach, C. N. Haney, and W. Rafaniello, "Rapid Carbothermal Reduction of Boron Oxide in a Graphite Transport Reactor," AIChE Journal, 37, 759 (1991); first reported demonstration that rapid carbothermal reduction (RCR) could synthesize submicron carbide particles that approached the size and quality of much more expensive laser-produced particles, but with a substantial cost/performance benefit. See (28, 29).

(42) U.S. Patent 5,380,688 (1995), "Method for Making Submicrometer Carbides, Submicrometer Solid Solution Carbides, and the Materials Resulting Therefrom," commercialized at Sandvik Coromant, http://www.coromant.sandvik.com/, for a captive market to baseload production of the highest quality cutting tools in the world (~ $500M/yr business); powders are not sold outside of

Sandvik, but instead the RCR process is used internally to produce the fine tungsten carbide powders that are then used to fabricate the majority of microdrills sold/used throughout the world today for printed circuit-board drilling.

(43) U.S. Patent 5,110,565 (1992)."Apparatus for Producing Uniform, Fine Ceramic Powders." Ultra-high temperature graphite transport tube reactor and reaction process for directly synthesizing submicron non-oxide ceramic powders such as WC, B_4C, and SiC. This process was commercialized by Dow Chemical and later by Sandvik Coromant for the manufacture of ultrafine WC powders for producing high-end cutting tools

(44) Weimer, A.W. and G.J. Quarderer, "On Dense Phase Voidage and Bubble Size in High Pressure Fluidized Beds of Fine Powders," AIChE Journal, 31, 1019 (1985). First demonstration that combined fluidized bed reactor operating pressure and catalyst particle size could be adjusted to control the maximum stable bubble size, or, could even make bubbles disappear within the chemical reactor.