

Geoff Brennecka
Assistant Professor
geoff.brennecka@mines.edu

Colorado School of Mines
303-384-2238 (office)
505-681-8879 (cell)

Education

Ph.D., Materials Science and Engineering, University of Illinois at Urbana-Champaign, 2006

Advisor: Prof. David A. Payne

Dissertation: Structural Origins of Enhanced Dielectric Properties in TiO₂-Modified Ta₂O₅ Ceramics

M.S., Ceramic Engineering, University of Missouri-Rolla, 2002

Advisor: Prof. Wayne Huebner

Thesis: Stress-Induced Orientation in Chemical Solution Deposited Tetragonal PZT Thin Films

B.S., Ceramic Engineering, University of Missouri-Rolla, 2001

Graduated *Summa Cum Laude*

Employment and Adjunct Appointments

Colorado School of Mines, Golden, CO

Metallurgical and Materials Engineering Department

Colorado Center for Advanced Ceramics

Assistant Professor, 2014 - present

Sandia National Laboratories, Albuquerque, NM

Electronic, Optical, and Nanostructured Materials Department

Principal Member of the Technical Staff, 2011 - 2014

Senior Member of the Technical Staff, 2007 - 2010

Post-Doctoral Appointee, 2006 - 2007

Middle Tennessee State University (MTSU)

Adjunct Graduate Faculty, Department of Recording Arts and Technologies, 2017 - present

Boise State University (BSU)

Adjunct Graduate Faculty, Department of Materials Science and Engineering, 2013 - present

Missouri University of Science and Technology (Missouri S&T)

Adjunct Professor, Department of Materials Science and Engineering, 2012 - present

New Mexico Institute of Mining and Technology (NMTech)

Adjunct Professor, Department of Materials Engineering, 2013

Awards and Honors

Fellow of the American Ceramic Society	2017
University of Illinois MatSE Department Young Alumnus Award <i>Awarded annually to a high-performing alumnus under the age of 40</i>	2017
NSF CAREER Award: Dynamic Defect Interactions in Ferroelectrics <i>Funded out of the Ceramics program from the Division of Materials Research</i>	2016

Du-Co Ceramics Young Professional Award <i>Young professional who demonstrates exceptional leadership and service to ACerS</i>	2015
IEEE-UFFC Ferroelectrics Young Investigator Award <i>Selected as the top international researcher in the ferroelectrics field under the age of 40</i>	2014
Distinguished Ceramic Alumnus Award from the Missouri S&T MSE department <i>Chosen by the current students and faculty</i>	2014
Selected to participate in the 2014 Japan-America Frontiers of Engineering Symposium <i>Recognizes fewer than 60 top engineers from the US and Japan between the ages of 30 and 45</i>	2014
Karl Schwartzwalder Professional Achievement in Ceramic Engineering Award <i>Nation's outstanding young ceramic engineer, selected by the National Institute of Ceramic Engineers</i>	2013
American Ceramic Society Emerging Leader Award <i>In recognition of exemplary service to the American Ceramic Society</i>	2010

Courses Taught

MTGN 272 <i>Particulate Materials Processing (Field Session)</i>	Su15, Su16, Su17 Colorado School of Mines
MTGN 412 <i>Ceramic Engineering</i>	F14, F15, F16 Colorado School of Mines
MTGN 466 <i>Materials Design and Synthesis (Senior Design)</i>	S15 Colorado School of Mines
MTGN 499 <i>Independent Study</i>	S16, F16 Colorado School of Mines
MLGN 598 <i>Anisotropic Dielectrics</i>	S17 Colorado School of Mines
MLGN 599 <i>Independent Study</i>	Su17 Colorado School of Mines
MATE 301 <i>Introduction to Ceramic Engineering</i>	S13 New Mexico Tech

Funded Projects at Mines

COUPLED: Computation Of Undiscovered Piezoelectrics and Linked Experiments for Design
NSF DMREF, \$1.5M over 4 yrs, 2015 *Lead PI*

- Co-PIs: Cristian Ciobanu, Paul Constantine, Corinne Packard, Vladan Stevanovic, and Andriy Zakutayev
- Parallel high-throughput computational and experimental effort to develop new piezoelectric materials
- Includes an Industrial Advisory Board (IAB) with nearly 20 members

Integration of High-Performance Ceramic Capacitors with Low-Cost Copper Electrodes via Advanced Kinetic Control

Colorado Office of Economic Development and International Trade, \$150k over 2 yrs, 2015 *Lead PI*

- Collaboration with Pneumaticoat (now ForgeNano) to develop process to integrate advanced BT-BZT-based dielectrics with copper electrodes

CAREER: SusChem: Dynamic Defect Interactions in Ferroelectrics*NSF CAREER Award, \$460k over 5 yrs, 2016**Lead PI*

- Investigating the fundamental interactions between a variety of defects and ferroelectric domain walls
- Extending quantitative understanding of domain dynamics to high power drive conditions

Nanoparticle Capacitors for Multipoint Initiation*Army SBIR with Aegis Technology, \$65k to Mines in Phases I and II, 2015-2017**Academic PI*

- Fabricating, testing, and characterizing advanced composite multilayer ceramic capacitors (MLCCs) for pulse discharge applications
- Suggesting process modifications based on characterization and testing results

Critical Evaluation of Additive Manufacturing for Critical Ceramic Components*Honeywell National Security Campus, \$45k + student for 2 yrs, 2016**Lead PI*

- Evaluating maturity, opportunities, and limitations of additive manufacturing techniques for electrical ceramic components
- Funding amount does not include student tuition, fees, salary, and consumables, all paid directly

Computational Framework for Dopant Segregation in Al₂O₃ and AlN*CoorsTek Fellowship, \$300k over 4 yrs, 2016**Lead PI*

- Extending DFT techniques to better handle single dopant and similar low-concentration environments
- Investigating energetics of dopant segregation in CoorsTek-relevant systems

Dielectrics under extreme electric fields: *In situ* studies on nanoscale mechanisms*DOE BES with Iowa State University, \$156k to Mines over 3 yrs, 2017**co-PI, led by Xiaoli Tan*

- Fundamental studies of dielectric breakdown in oxide thin films
- *In situ* TEM studies with high spatial and temporal resolution

Additional Funded Activities

- CSM Tech Fee, \$5k for a pair of 3D printers and accessories, 2015
- MRS Foundation, \$8k for a glass melter for the CSM hot glass shop, 2016
- NSF EAPSI Program, \$9k for Jake Ivy to study with Prof. John Daniels at UNSW in Australia, 2016
- CSM Tech Fee, \$40k for equipment to build a hot glass shop in the MME Foundry, 2016
- CSM Tech Fee, \$18k for rheometer, 2016
- REMRSEC Seed Program, \$5k for proposal development, 2017

Professional Society and Service Activities**The American Ceramic Society (ACerS):****Board of Directors:** Member 2014-17, Finance Committee 2014-15, 16-17**Electronics Division:** Chair 2016-17, other officers 2013-16; Historian 2008**Education Integration Committee:** Chair 2012-14**National Institute of Ceramic Engineers (NICE):** President 2011-12, other officers 2008-11**Education & Student Programs Presidential Advisory Committee:** Co-Chair 2012**David W. Kingery Award Committee:** Member 2012-13; Chair 2014**Du-Co Ceramics Young Professional Award Committee:** Member 2016, Chair 2013

Arthur L. Friedberg Award Committee: Member 2011-13

Arthur Frederick Greaves-Walker Award Committee: Member 2013-16

Helped ACerS launch the **Young Professionals Network (YPN)** in 2009

Co-founded the ACerS **President's Council of Student Advisors** in 2008; served as Mentor ever since

IEEE:

Member of Ultrasonics, Ferroelectrics, and Frequency Control Society (UFFC)

UFFC Administrative Committee (AdCom): Elected member, 2014-17

UFFC AdCom Education Committee: 2015-17, Chair 2016-17

Ferroelectrics Committee (FerroCom): Elected member, 2011-present

FerroCom Education Committee: Chair, 2016-present

FerroCom Technical Programming Chair: Processing, 2013-present

Elevated to Senior Member in 2011

Member of Nuclear and Plasma Sciences Society (NPSS)

Member of Power Electronics Society (PELS)

Member of Dielectrics and Electrical Insulation Society (DEIS)

Colorado School of Mines:

Graduate Council, 2015-17

MME Assessment/ABET Committee, 2014-17, Chair 2016-17; head of curriculum review, 2015-17

MME Graduate Affairs Committee, 2014-15

MME Undergraduate Affairs Committee, 2015-17

Materials Science Graduate Admissions Committee, 2015-17

CASE Graduate Student Recruitment Committee, 2016-17

MME and Materials Science Graduate Student Recruitment Coordinator, 2014-17

MME Search Committee for EM lab manager, 2014-15

MME Search Committee for junior faculty, 2014-15

Fulbright student application review committee, 2014-15

Research Council, 2014

Materials Research Society (MRS): Active member since 2003

Thesis Examiner for the Dept. of Materials Science and Engineering at the Univ. of New South Wales, Australia, 2016

Alumni Board for the Dept. of Materials Science and Engineering at the Univ. of Illinois, 2012-16

Industrial Advisory Board for the Center for Dielectrics and Piezoelectrics (NSF I/UCRC), 2012-14

Conferences and Symposia Organized

IEEE ISAF

2020

Lead organizer of entire meeting

Keystone, CO

14th International Ceramics Congress

2018

International Advisory Board

Salsomaggiore Terme, Italy

NSF Professional Development Workshop in Ceramics

2017

Lead organizer of entire meeting

Waikaloa, HI

Electronic Materials and Applications <i>Lead organizer of entire meeting</i>	2017 Orlando, FL
5G Materials for the Millimeter Wave Revolution <i>Electronic Materials and Applications</i>	2017 Orlando, FL
IEEE ISAF-ECAPD-PFM Joint Meeting <i>Processing lead for the Technical Programming Committee for ISAF</i>	2016 Darmstadt, Germany
IEEE Future Directions Smart Materials Initiative Workshop <i>Lead organizer</i>	2016 Golden, CO
Electronic Materials and Applications <i>Co-organizer of entire meeting</i>	2015 Orlando, FL
International Symposium for the Application of Ferroelectrics, ISAF <i>Processing lead for the Technical Programming Committee for ISAF</i>	2015 Biopolis, Singapore
Advanced Solution and Colloidal Processing for Ceramics <i>MS&T 2014</i>	2014 Pittsburgh, PA
Solution Proc. & Prop. of Funct. Oxide Thin Films & Nanostructures <i>Spring EMRS</i>	2014 Lille, France
Solution-Based Processing for Ceramic Materials <i>MS&T 2013</i>	2013 Montreal, QC, Canada
IEEE UFFC Joint Meeting, ISAF <i>Processing lead for the Technical Programming Committee for ISAF</i>	2013 Prague, Czech Republic
Production Quality Ferroelectric Thin Films and Devices <i>Electronic Materials and Applications</i>	2013 Orlando, FL
Failure: The Greatest Teacher <i>Electronic Materials and Applications</i>	2013-17 Orlando, FL
Solution-Based Processing for Ceramic Materials <i>MS&T 2012</i>	2012 Pittsburgh, PA
Education and Student Programs Thrust Leader <i>Materials Challenges for Alternative and Renewable Energy</i>	2012 Clearwater, FL
Solution-Based Processing for Ceramic Materials <i>MS&T 2011</i>	2011 Columbus, OH
Nano Phenomena & Surface, Interfacial Effects in Electronic Ceramics <i>Electronic Materials and Applications</i>	2010, 2011 Orlando, FL
Highlights of Student Research in Basic Science & Electronic Ceramics <i>Electronic Materials and Applications</i>	2011-14 Orlando, FL
The Future of Electronic Ceramics: A New Investigator Symposium <i>Electronic Materials and Applications</i>	2010 Orlando, FL
Rio Grande Symposium on Advanced Materials <i>co-organizer 2009-11, 2013; lead organizer in 2012</i>	2009-13 Albuquerque, NM
17th International Symposium on the Applications of Ferroelectrics & 2008 Meeting of the Electronics Div. of the American Ceramic Society <i>co-organizer of entire meeting</i>	2008 Santa Fe, NM

Editorial and Peer-Review Activities

Editor for the *Journal of the American Ceramic Society* 2017-present

Associate Editor for the *Journal of the American Ceramic Society* 2010-2017

Associate Editor for the *Journal of Electronic Materials* 2013-15

Associate Editor for a Special Issue of the *Transactions of the IEEE-UFFC* 2010

Editor for *Ceramic Transactions v249 and v252, Processing and Properties of Advanced Ceramics and Composites VI and VII*

Peer Reviewer for >30 journals including *Phys. Rev. Lett.*, *Appl. Phys. Lett.*, *J. Appl. Phys.*, *J. Am. Ceram. Soc.*, *J. Am. Chem. Soc.*, *J. Mater. Res.*, *Acta Mater.*, *ACS Nano*, and *J. Electrochem. Soc.*

Refereed Publications (*h* index = 15), <per-article citations to date>

1. S. Manna, G.L. Brennecka, V. Stevanovic, and C.V. Ciobanu, "Tuning the piezoelectric and mechanical properties of the AlN system via alloying with YN and BN," *J. Appl. Phys.*, **in review** (2017).
2. B.M. Foley, E.A. Paisley, C.B. DiAntonio, T. Chavez, M.A. Blea-Kirby, G.L. Brennecka, J.T. Gaskins, J.F. Ihlefeld, and P.E. Hopkins, "Phonon Scattering Mechanisms Dictating the Thermal Conductivity of Lead Zirconate Titanate (PbZr_{1-x}Ti_xO₃) Thin Films Across the Compositional Phase Diagram," *J. Appl. Phys.*, **highlighted as Editor's Pick, accepted** (2017). [doi](#)
3. C.-F. Chen, G.L. Brennecka, G. King, E.L. Tegtmeier, T. Holesinger, J. Ivy, and P. Yang, "Processing of crack-free high density polycrystalline LiTaO₃ ceramics," *J. Mater. Sci: Mater. Electron.*, **28**, 3725-32 (2016). [doi](#)
4. M. Beuerlein, N. Kumar, T.-M. Usher, H.J. Brown-Shaklee, N. Raengthon, D.P. Cann, J.L. Jones, I. Reaney, and G.L. Brennecka, "Current Understanding of Structure-Processing-Property Relationships in BaTiO₃-Bi(M)O₃ Dielectrics," **Invited Feature Article with Cover Art**, *J. Am. Ceram. Soc.*, **99**[9], 2849-70 (2016). [doi](#) <6>
5. W. Meier, K.E. Meyer, D.F. Sava Gallis, M.A. Blea-Kirby, J.R. Roth, D. Felman, T. Breuer, G.J. Denison, F.J. Zutavern, W. Huebner, and G.L. Brennecka, "Highly Textured BaTiO₃ via Templated Grain Growth and Resulting Polarization Reversal Dynamics," *J. Am. Ceram. Soc.*, **99**[3], 922-929 (2016). [doi](#) <2>
6. M.C. George, M.A. Rodriguez, M.S. Kent, G.L. Brennecka, and P.E. Hopkins, "Thermal conductivity of self-assembling symmetric poly(styrene)-block-poly(methyl methacrylate) thin films," *J. Heat Trans.*, **138**, 024505 (2015). [doi](#)
7. J.L. Jones, J.M. LeBeau, J. Nikkel, A. Oni, H. Dycus, C. Cozzan, F.-Y. Lin, A. Chernatynskiy, J.C. Nino, S. Sinnott, S. Mhin, G.L. Brennecka, and J.F. Ihlefeld, "Combined experimental and computational methods reveal the evolution of buried interfaces during synthesis of ferroelectric thin films," *Adv. Mater. Interf.*, **2**[10], 2196 (2015). [doi](#) <6>
8. C.D. Landon, R.H.T. Wilke, M.T. Brumbach, G.L. Brennecka, M.A. Blea-Kirby, J.F. Ihlefeld, M. Marinella, and T.E. Beechem, "Thermal Transport in Tantalum Oxide Films for Memristive Applications," *Appl. Phys. Lett.*, **107**, 023108 (2015). [doi](#) <2>
9. J.F. Ihlefeld, P.G. Kotula, B.D. Gauntt, D. Gough, G.L. Brennecka, P. Lu, and E.D. Spoerke, "Solution chemistry, substrate, and processing effects on chemical homogeneity in lead zirconate titanate thin films," *J. Am. Ceram. Soc.*, **98**[7], 2028-2038 (2015). [doi](#) <4>

10. A. Henriques, J.T. Graham, S. Landsberger, J.F. Ihlefeld, G.L. Brennecka, D.W. Brown, J.S. Forrester, and J.L. Jones, "Crystallographic changes in lead zirconate titanate due to neutron irradiation," *AIP Advances*, **4** 117125 (2014). doi <4>
11. R. Kirchhofer, D.R. Diercks, B.P. Gorman, J.F. Ihlefeld, P.G. Kotula, C.T. Shelton, and G.L. Brennecka, "Quantifying Compositional Homogeneity in Pb(Zr,Ti)O₃ Using Atom Probe Tomography," **Invited Feature Article with Cover Art**, *J. Am. Ceram. Soc.*, **97**[9] 2677-97 (2014). doi <13>
12. N. Triamnak, G.L. Brennecka, H.J. Brown-Shaklee, M.A. Rodriguez, and D.P. Cann, "Phase formation of BaTiO₃ - Bi(Zn_{1/2}Ti_{1/2})O₃ perovskite ceramics," *J. Ceram. Soc. Jpn.*, **122**[4] 260-266 (2014). doi <7>
13. S. Mhin, K. Nittala, J. Lee, D.S. Robinson, J.F. Ihlefeld, G.L. Brennecka, L.M. Sanchez, R.G. Polcawich, and J.L. Jones, "Phase and Texture Evolution in Chemically Derived PZT Thin Films on Pt Substrates," *J. Am. Ceram. Soc.*, **97**[9] 2973-9 (2014). doi <7>
14. R.J. Bondi, M.P. Desjarlais, A.P. Thompson, G.L. Brennecka, and M.J. Marinella, "Electrical Conductivity in Oxygen-Deficient Phases of Tantalum Pentoxide from First-Principles Calculations," *J. Appl. Phys.*, **114** 203701 (2013). doi <17>
15. R. Kirchhofer, D.R. Diercks, B.P. Gorman, and G.L. Brennecka, "Atomic scale composition profiling of ferroelectrics via laser-pulsed atom probe tomography and cross-correlative transmission electron microscopy," *Microscopy and Microanalysis* 19(S2), 980-1 (2013). doi <3>
16. N.W. Moore, H.J. Brown-Shaklee, M.A. Rodriguez, and G.L. Brennecka, "Optical anisotropy near the relaxor-ferroelectric phase transition in lanthanum lead zirconate titanate," *J. Appl. Phys.*, **114** 053515 (2013). doi <2>
17. S. Mhin, C. Cozzan, J.L. Jones, K. Nittala, P. Wanninkhof, J.F. Ihlefeld, and G.L. Brennecka, "Effect of Switching Atmospheric Conditions During Crystallization on the Phase Evolution of Solution-Derived Lead Zirconate Titanate Thin Films," *J. Am. Ceram. Soc.*, **96**[9] 2706-2709 (2013). doi <7>
18. K. Nittala, S. Mhin, K.M. Dunnigan, D.S. Robinson, J.F. Ihlefeld, P.G. Kotula, G.L. Brennecka, and J.L. Jones, "Phase and texture evolution in solution deposited lead zirconate titanate thin films: Formation and role of the Pt₃Pb intermetallic phase," *J. Appl. Phys.*, **113** 244101 (2013). doi <15>
19. L.J. Small, M.T. Brumbach, C.A. Apblett, J.F. Ihlefeld, G.L. Brennecka, and D.J. Duquette, "On the Degradation Processes of Thin Film PZT in 0.1 N H₂SO₄," *J. Electrochem. Soc.*, **160**[3] C128-c135 (2013). doi <1>
20. J.T. Graham, G.L. Brennecka, P. Ferreira, L.J. Small, D. Duquette, C.A. Apblett, S. Landsberger, and J.F. Ihlefeld, "Neutron irradiation effects on domain wall mobility and reversibility in lead zirconate titanate thin films," *J. Appl. Phys.*, **113**, 124104 (2013). doi <13>
21. N. Raengthon, H.J. Brown-Shaklee, G.L. Brennecka, and D.P. Cann, "Dielectric Properties of BaTiO₃ - Bi(Zn_{1/2}Ti_{1/2})O₃ - NaNbO₃ Solid Solutions," *J. Mater. Sci.*, **48**, 031401 (2012). doi <20>
22. N. Raengthon, V.J. DeRose, G.L. Brennecka, and D.P. Cann, "Defect Mechanisms in High Resistivity BaTiO₃ - Bi(Zn_{0.5}Ti_{0.5})O₃ Ceramics," *Appl. Phys. Lett.*, **101**, 112904 (2012). doi <18>
23. K. Nittala, S. Mhin, J.L. Jones, D.S. Robinson, J.F. Ihlefeld, and G.L. Brennecka, "In situ X-ray diffraction of solution-derived ferroelectric thin films for quantitative phase and texture evolution measurement," *J. Appl. Phys.*, **112**, 104109 (2012). doi <11>
24. C.T. Shelton, P.G. Kotula, G.L. Brennecka, P.G. Lam, K.E. Meyer, J.-P. Maria, B.J. Gibbons, and J.F. Ihlefeld, "Chemically Homogeneous Complex Oxide Thin Films Via Improved Substrate Metallization," **Featured on the Journal Cover**, *Adv. Funct. Mater.*, **22**[11] 2295-2302 (2012). doi <48>

25. L.J. Small, C.A. Appleby, J.F. Ihlefeld, G.L. Brennecka, and D. Duquette, "Electrochemical Response of Ferroelectric $\text{PbZr}_{0.52}\text{Ti}_{0.48}\text{O}_3$ Thin Films," *J. Electrochem. Soc.*, **159** [8], C357-C363 (2012). [doi <3>](#)
26. C.-F. Chen, A. Llobert, G.L. Brennecka, R.T. Forsyth, D.R. Guidry, P.A. Papin, and R.J. McCabe, "Powder Synthesis and Hot-Pressing of a LiTaO_3 Ceramic," *J. Am. Ceram. Soc.*, **95** [9], 2820-6 (2012). [doi <6>](#)
27. L.J. Small, A. Cook, C.A. Appleby, J.F. Ihlefeld, G.L. Brennecka, and D. Duquette, "An Automated Electrochemical Probe for Evaluation of Thin Films," *J. Electrochem. Soc.*, **159**[4] F87-F90 (2012). [doi <5>](#)
28. K. Nittala, G.L. Brennecka, B.A. Tuttle and J.L. Jones, "Phase evolution in solution deposited Pb deficient PLZT thin films," *J. Mater. Sci.*, **46**[7], 2148-54 (2011). [doi <12>](#)
29. J. Graham, S. Landsberger, P.J. Ferreira, J.F. Ihlefeld, and G.L. Brennecka, "Neutron flux characterization techniques for radiation effects studies," *J. Radioanal. Nucl. Chem.*, **291**[2] 503-7 (2012). [doi <5>](#)
30. J.F. Ihlefeld, S.H. Baek, C.M. Folkman, J.F. Carroll III, G.L. Brennecka and C.-B. Eom, "Effect of domain structure on dielectric nonlinearity in epitaxial BiFeO_3 films," *Appl. Phys. Lett.*, **97** 262904 (2011). [doi <17>](#)
31. G.L. Brennecka, J.F. Ihlefeld, J.-P. Maria, B.A. Tuttle and P.G. Clem, "Processing Technologies for High Permittivity Thin Films in Capacitor Applications," **Invited Feature Article with Cover Art**, *J. Am. Ceram. Soc.*, **93**[12] 3935-54 (2010). [doi <88>](#)
32. G.L. Brennecka, C.M. Parish, B.A. Tuttle, and L.N. Brewer, "Reversibility of the Perovskite-to-Fluorite Phase Transformation in Lead-Based Thin and Ultrathin Films," *Adv. Mater.*, **20**[8] 1407-11(2008). [doi <50>](#)
33. J. Sigman, G.L. Brennecka, P.G. Clem, and B.A. Tuttle, "Advances in the Fabrication of Perovskite Based High-Value Integrated Capacitors by Chemical Solution Deposition," *J. Am. Ceram. Soc.*, **91**[6] 1851-7 (2008). [doi <54>](#)
34. C.M. Parish, G.L. Brennecka, B.A. Tuttle, and L.N. Brewer, "Quantitative X-ray Spectrum Imaging of Lead Lanthanum Zirconate Titanate PLZT Thin-Films," *J. Am. Ceram. Soc.*, **91**[11] 3690-7 (2008). [doi <31>](#)
35. C.M. Parish, G.L. Brennecka, B.A. Tuttle, and L.N. Brewer, "Quantitative Chemical Analysis of Fluorite-to-Perovskite Transformations in $(\text{Pb},\text{La})(\text{Zr},\text{Ti})\text{O}_3$," *J. Mater. Res.*, **23**[11] 2944-53 (2008). [doi <9>](#)
36. G.L. Brennecka, C.M. Parish, B.A. Tuttle, and L.N. Brewer, "Multilayer Thin and Ultrathin Film Capacitors Fabricated by Chemical Solution Deposition," *J. Mater. Res.*, **23**[1] 176-81 (2008). [doi <28>](#)
37. G.L. Brennecka and D.A. Payne, "Densification and Grain Growth for Powder-Derived Ta_2O_5 - TiO_2 Ceramics," *J. Ceram. Soc. Jpn.*, **115**[10] 678-82 (2007). **Featured on front cover.** [doi](#)
38. G.L. Brennecka and B.A. Tuttle, "Fabrication of Ultrathin Film Capacitors by Chemical Solution Deposition," *J. Mater. Res.*, **22**[10] 2868-74 (2007). [doi <44>](#)
39. G.L. Brennecka, D.A. Payne, H. Hellwig, P. Sarin and W.M. Kriven, "Phase transformations in the High Temperature Form of Pure and TiO_2 -stabilized Ta_2O_5 ," *J. Am. Ceram. Soc.*, **90**[9] 2947-53 (2007). [doi <15>](#)

40. G.L. Brennecka and D.A. Payne, "Preparation of dense Ta₂O₅-based ceramics by a coated-powder method for enhanced dielectric properties," *J. Am. Ceram. Soc.*, **89**[7] 2089-95 (2006). doi <12>
41. G.L. Brennecka, W. Huebner, B.A. Tuttle and P.G. Clem. "Use of stress to orient tetragonal (40/60) PZT thin films and resulting electrical properties," *J. Am. Ceram. Soc.*, **87**[8] 1459-65 (2004). doi <46>
42. P.G. Clem, N.S. Bell, G.L. Brennecka, B.H. King and D.B. Dimos, "Microopen printing of electronic components," p229-59 in *Direct Write Methods for Rapid Prototyping and Sensors*. Edited by A. Pique and D. B. Chrisey. Academic Press, San Diego, 2002. doi <6>
43. T.J. Boyle, P.G. Clem, B.A. Tuttle, G.L. Brennecka, J.T. Dawley, M.A. Rodriguez, T.D. Dunbar and W.F. Hammetter, "Lanthanide series doping effects in lead zirconate titanate (PLnZT) thin films," *J. Mater. Res.*, **17**[4] 871-8 (2002). doi <30>

Patents and Applications

1. G.L. Brennecka, S.F. Glover, G.E. Pena, and F.J. Zutavern, "Ferroelectric Opening Switch," United States Provisional Patent Application #15137539 (2016).
2. G.L. Brennecka, H.J. Brown-Shaklee, D.P. Cann, N. Raengthon, and N. Kumar, "Thermally Stable High Performance Dielectrics," United States Patent Application #0071646 A1 (2016).
3. J.C. Neely, J. Flicker, S.F. Glover, and G.L. Brennecka "Low-Inductance Direct Current Power Bus," United States Provisional Patent Application #62292473 (2016).

Conference Proceedings and Other Publications

1. G.L. Brennecka, "Importance of Reaction Pathways in Microstructure Development of $x\text{Bi}(\text{Zn}_{0.5}\text{Ti}_{0.5})\text{O}_3-(1-x)\text{BaTiO}_3$ Ceramics", Proceedings of the 17th US-Japan Seminar on Advanced Dielectrics and Piezoelectrics, Matsumoto, Japan (2015).
2. G.L. Brennecka, B. Winchester, "Simulation Studies of Nucleation of Ferroelectric Polarization Reversal," SAND2014-16529 (2014).
3. G.L. Brennecka, "For materials world, and those in it, the future looks bright," *Am. Ceram. Soc. Bull.*, **93**[2] 14-15 (2014).
4. G.L. Brennecka, F.J. Zutavern, G.J. Dension, G.E. Peña, S.F. Glover, M.B. Sinclair, and M.A. Blea-Kirby, "Controlled Polarization Reversal for Ferroelectric Opening Switches," SAND2013-10422 (2013).
5. G.L. Brennecka, H.J. Brown-Shaklee, N. Raengthon, M.A. Blea-Kirby, and D.P. Cann, "Capacitor Development for Reliable High Temperature Operation in Inverter Applications," Proceedings of the Electrical Energy Storage Applications and Technologies (EESAT) international conference, San Diego, CA (2013).
6. H.J. Brown-Shaklee, J.J. Borchardt, N. Raengthon, D.P. Cann, and G.L. Brennecka, "Pulse discharge behavior of relaxor dielectric multilayer ceramic capacitors," Proceedings of the 16th US-Japan Seminar on Dielectric and Piezoelectric Materials, Raleigh, NC (2013).
7. D.P. Cann, N. Raengthon, H.J. Brown-Shaklee, and G.L. Brennecka, "BaTiO₃-Bi(Zn_{1/2}Ti_{1/2})O₃ Relaxor Materials for Advanced Capacitor Applications," Proceedings of the 16th US-Japan Seminar on Dielectric and Piezoelectric Materials, Raleigh, NC (2013).

8. J.F. Ihlefeld, P.G. Kotula, B. Gauntt, D.V. Gough, G.L. Brennecka, B.B. McKenzie, A. Allen, M.A. Blea-Kirby, H.J. Brown-Shaklee, and E.D. Spoecke, "Substrate and Solution Chemistry Effects on Chemical Homogeneity in $\text{PbZr}_{0.52}\text{Ti}_{0.48}\text{O}_3$ Thin Films on Platinized Silicon Substrates," Proceedings of the 16th US-Japan Seminar on Dielectric and Piezoelectric Materials, Raleigh, NC (2013).
9. R. Kirchhofer, D. R. Diercks, B. P. Gorman, and G. Brennecka, "Atomic Scale Composition Profiling of Ferroelectrics via Laser-Pulsed Atom Probe Tomography and Cross-correlative Transmission Electron Microscopy," *Microsc. Microanal.*, **S2** (2013).
10. F.J. Zutavern, G.L. Brennecka, S.F. Glover, G.E. Pena, G.J. Dension, and J.M. Rudys, "A Testbed for High Voltage, High Bandwidth Characterization of Nonlinear Dielectrics," *Proceedings of the 19th IEEE Pulsed Power Conference*, San Francisco, CA (2013).
11. N.W. Moore and G.L. Brennecka, "Optical Properties of PZT Ferroelectrics through Thermally-Driven Phase Transformations," SAND2013-5228 (2013).
12. M.S. Kent, J.G. Cordaro, G.L. Brennecka, and M.C. George, "Triblock polymers for nanoporous membranes: Characterization of phase behavior," SAND2012-10859 (2012).
13. J.F. Ihlefeld, G.L. Brennecka, L.J. Small, C.A. Aplett, B.A. Tuttle, P. Mahoney, J.L. Jones, K. Nittala, S.W. Mhin, K. Dunnigan, D. Duquette, S. Calabrese, S. Landsberger, P. Ferreira, J. Graham, and D.S. Robinson, "Enabling Self-Powered Ferroelectric Nanosensors: Fundamental Science of Interfacial Effects Under Extreme Conditions", SAND2012-7797 (2012).
14. G.L. Brennecka and K. Fox, "Back to School: Revived EIC boosts Society's education efforts," *Am. Ceram. Soc. Bull.*, **92**[2] 14 (2013).
15. D.B. Burckel, C.-Y.P. Yang, E.L. Yang, C.A. Steinhaus, and G.L. Brennecka, "Integration of Block-Copolymer with Nano-Imprint Lithography: Pushing the Boundaries of Emerging Nano-Patterning Technology," SAND2012-8414 (2012).
16. J.T. Graham, S. Landsberger and G.L. Brennecka, "Ferroelectric Changes in Neutron Irradiated Lead Zirconate Titanate," *Trans. Am. Nucl. Soc.*, **104**, 241-2 (2011).
17. G.L. Brennecka, K.E. Meyer, Y.H. Jeon, D. Shahin, H.J. Brown-Shaklee, B. Gibbons, and J.F. Ihlefeld, "Minimizing Voltage Tuning for Enhanced High Field Energy Storage," Proceedings of the 15th US-Japan Seminar on Dielectric and Piezoelectric Ceramics, Kagoshima, Japan (2011).
18. J.F. Ihlefeld, C.T. Shelton, P.G. Kotula, G.L. Brennecka, P.G. Lam, K.E. Meyer, J.P. Maria, and B. Gibbons, "Chemically Homogeneous Ferroelectric Thin Films via Improved Substrate Metallization," Proceedings of the 15th US-Japan Seminar on Dielectric and Piezoelectric Ceramics, Kagoshima, Japan (2011).
19. G.L. Brennecka and B. Fahrenholtz, "Replace yourself: Some student advisors' perspectives on ceramic education," *Am. Ceram. Soc. Bull.*, **89**[5] 35 (2010).
20. G.L. Brennecka, B.A. Tuttle, J. Stevens, A. Gin, and D. Scrymgeour, "Nanopatterned Ferroelectrics for Ultrahigh Density Rad-Hard Nonvolatile Memories," SAND2010-7085 (2010).
21. K. Reed, J. Rudys, G. Pena, S. Glover, G. Brennecka, and B. Tuttle, "Ferroelectric Opening Switches for Large Scale Pulsed Power Drivers" SAND2009-7527 (2009).
22. G.L. Brennecka, C.M. Parish, J.L. Jones, B.A. Tuttle, J.S. Wheeler, and J.G. Ekerdt, "Chemical, Phase, and Interface Effects in Solution-Based Fabrication of Ferroelectric Thin Film Capacitors," Proceedings of the 14th US-Japan Seminar on Dielectric and Piezoelectric Ceramics, Welches, OR (2009).
23. G.L. Brennecka, C.M. Parish, D.A. Scrymgeour, B.A. Tuttle, L.N. Brewer and J.G. Ekerdt, "Micro- and nano-patterning of solution-derived functional electronic ceramics," *Microscopy and Microanalysis*, **14** [suppl. 2] 1432-33 (2008).

24. C.M. Parish, G.L. Brennecka, B.A. Tuttle and L.N. Brewer, "Quantitative STEM-EDS spectrum imaging of phase transformations in (Pb,La)(Zr,Ti)O₃," *Microscopy and Microanalysis*, **14** [suppl. 2] 1434-35 (2008).
25. G.L. Brennecka, C.M. Parish, B.A. Tuttle, M.A. Rodriguez, L.N. Brewer and J.S. Wheeler, "Recent Advances in the Fabrication of Solution-Derived Thin and Ultrathin Multilayer Capacitors," *IEEE Internat. Symp. Appl. Ferroelec. (ISAF)*. Santa Fe, NM (2008).
26. J. Sigman, P.G. Clem, G.L. Brennecka and B.A. Tuttle, "Fabrication of (Ba,Sr)TiO₃ high-value integrated capacitors by chemical solution deposition," *IEEE Internat. Symp. Appl. Ferroelec. (ISAF)*. Santa Fe, NM (2008).
27. G.L. Brennecka, B.A. Tuttle, C.M. Parish, L.N. Brewer, B.B. McKenzie, and M.A. Rodriguez, "Fabrication of Ultrathin Integrated Multilayer Capacitors by Chemical Solution Deposition," Proceedings of the 13th US-Japan Seminar on Dielectric and Piezoelectric Ceramics, Awaji City, Hyogo, Japan (2007).
28. G.L. Brennecka and D.A. Payne, "Densification and grain growth in powder-derived Ta₂O₅-based dielectrics," *Proc. of the 9th International Ceramic Processing Science Symposium*. Coral Gables, FL (2006).
29. B.A. Tuttle, G.L. Brennecka, D.P. Williams, M.A. Rodriguez, T.J. Headley and J.S. Wheeler, "High energy density PLZT thin film capacitors"; *Ceramic Transactions, v162, Advanced Dielectric, Piezoelectric, and Ferroelectric Thin Films*. Proc. of the 106th Annual Meeting of the American Ceramic Society, p.17-25 (2005).
30. D.A. Payne, G.L. Brennecka, D.L. West and J.U. Knickerbocker, "Processing of textured ceramics for electrical applications," p199-207 in *Processing of Electroceramics*. Edited by M. Kosec, D. Kuscer and B. Malic. Jozef Stefan Institut, 2003.

Invited Conference Talks

1. G.L. Brennecka and M.A. Beuerlein, "Processing and Base-Metal Integration of Bi(M)O₃-BaTiO₃ Dielectrics," 12th Pacific Rim Conference on Ceramic and Glass Technology (PacRim 12), Waikoloa, HI (2017).
2. G.L. Brennecka, "Processing and Integration Science of Capacitors Based on Bi(M)O₃-BaTiO₃ Dielectrics for High Field and/or High Temperature Operation," International Conference on Advanced Ceramics and Composites, Daytona Beach, FL (2017).
3. G.L. Brennecka, "Ferroelectric Domain Wall Dynamics Under High Power Drive Conditions," Invited talk at the 53rd Annual Technical Meeting of the Society of Engineering Science, College Park, MD (2016).
4. G.L. Brennecka, "Functional Complex Oxide Thin Films for Integrated Dielectric and Piezoelectric Applications," Invited talk at the Fall meeting of the European Materials Research Society, Warsaw, Poland (2016).
5. G.L. Brennecka, "Chemical heterogeneity in electroceramics: the good, the bad, and the difficult to characterize!," Invited talk at Composites at Lake Louise, Lake Louise, Alberta, CA (2015).
6. G.L. Brennecka, "Importance of Reaction Pathways in Microstructure Development of x Bi(Zn_{0.5}Ti_{0.5})O₃-(1- x)BaTiO₃ Ceramics," Invited talk at the 17th US-Japan Seminar on Advanced Dielectrics and Piezoelectrics, Matsumoto, Japan (2015).

7. G.L. Brennecka, "Capacitor Development for Reliable High Temperature Operation in Inverter Applications," Keynote address of the *Advances in Polar, Magnetic and Semiconductor Materials: Extending Temperature Limits* Symposium of Materials Science and Technology (MS&T'15), Columbus, OH (2015).
8. G.L. Brennecka, H.J. Brown-Shaklee, N. Raengthon, N. Triamnak, D.P. Cann, M.A. Blea-Kirby, and S. Atcitty, "Capacitor Development for Reliable High Temperature Operation in Inverter Applications," Presented at MS&T'14, Pittsburgh, PA (2014).
9. G.L. Brennecka, H.J. Brown-Shaklee, N. Raengthon, N. Triamnak, D.P. Cann, and S. Atcitty, "Capacitor Development for Reliable High Temperature Operation in Inverter Applications," Presented at the TMS Spring Meeting, San Diego, CA (2014).
10. G.L. Brennecka, H.J. Brown-Shaklee, J.J. Borchardt, N. Raengthon, and D.P. Cann, "Pulse discharge behavior of relaxor dielectric multilayer ceramic capacitors," Presented at the 16th US-Japan Seminar on Dielectric and Piezoelectric Materials, Raleigh, NC (2013).
11. G.L. Brennecka, J.F. Ihlefeld, K. Nittala, K.E. Meyer, C.T. Shelton, L.J. Small, and J.L. Jones, "Chemical and Thermal Effects on Phase Evolution and Cation Gradients in Solution-Derived Thin Film Ferroelectrics," Presented at the International Symposium on Integrated Functionalities, Grapevine, TX (2013).
12. G.L. Brennecka and J.F. Ihlefeld, "Chemical and Thermal Effects on Phase Evolution and Cation Gradients in Solution-Derived Thin Film Ferroelectrics," Presented at the 37th International Conference and Expo on Advanced Ceramics and Composites, Daytona Beach, FL (2013).
13. G.L. Brennecka, J.F. Ihlefeld, K. Nittala, J.L. Jones, M.C. George, L.D. Williamson, and P.F. Nealey, "Chemical, Phase, and Interface Effects in Solution-Based Fabrication of Continuous and Nanopatterned Thin Film Ferroelectrics," Presented at the Spring 2012 meeting of the Materials Research Society, San Francisco, CA (2012).
14. G.L. Brennecka, J.F. Ihlefeld, K. Nittala, S. Mhin, J.L. Jones, and C.T. Shelton, "Chemical, Phase, and Interface Effects in Solution-Based Fabrication of Thin Film Ferroelectrics," Presented at Interfacial Phenomena in Nanostructured Materials and Devices, Telluride, CO (2012).
15. G.L. Brennecka, K.E. Meyer, Y.H. Jeon, D.I. Shahin, H.J. Brown-Shaklee, B. Gibbons, and J.F. Ihlefeld "Minimizing Voltage Tuning for Enhanced High Field Energy Storage," Presented at the 15th US-Japan Seminar on Dielectric and Piezoelectric Materials, Kagoshima, Japan (2011).
16. G.L. Brennecka, J.F. Ihlefeld, C.T. Shelton, P.G. Kotula, P.G. Lam, K.E. Meyer, J.P. Maria, and B. Gibbons, "Chemically Homogeneous Ferroelectric Thin Films via Improved Substrate Metallization," Presented at the 15th US-Japan Seminar on Dielectric and Piezoelectric Ceramics, Kagoshima, Japan (2011).
17. G.L. Brennecka, K.E. Meyer, H.J. Brown-Shaklee, D.I. Shahin, M.C. George, and J.F. Ihlefeld "Oxide Nanocomposites for Tailored Dielectric Responses," Presented at Composites at Lake Louise, Lake Louise, Canada (2011).
18. G.L. Brennecka, J.F. Ihlefeld, K. Nittala, J.L. Jones, C.T. Shelton, and J.-P. Maria, "Chemical, Phase, and Interface Effects in Solution-Based Fabrication of Continuous and Nanopatterned Thin Film Ferroelectrics," Fall meeting of the European Materials Research Society 2011, Warsaw, Poland (2011).
19. G.L. Brennecka, J.L. Jones, K. Nittala, S. Ji, and P.F. Nealey, "Fabrication, Patterning, and Integration of Functional Nanoscale Electronic Oxides," Presented at MS&T 2010, Houston, TX (2010).
20. G.L. Brennecka, K. Nittala, J.L. Jones, P. Lu, C.M. Parish, and B.A. Tuttle, "Materials Processing Challenges and Advances for PZT-Based PiezoMEMS," 2010 U.S. Navy Workshop on Acoustic Transduction Materials and Devices, State College, PA (2010).

21. G.L. Brennecka, K.E. Meyer, P.A. Mahoney, B.A. Tuttle, J.L. Jones, K. Nittala, P.F. Nealey, and S. Ji, "Fabrication, Patterning, and Integration of Functional Nanoscale Electronic Oxides," Presented at Composites at Lake Louise, Lake Louise, Alberta, Canada (2009).
22. G.L. Brennecka, C.M. Parish, J.L. Jones, B.A. Tuttle, J.S. Wheeler, and J.G. Ekerdt, "Chemical, Phase, and Interface Effects in Solution-Based Fabrication of Ferroelectric Thin Film Capacitors," **Plenary talk** presented at the 14th US-Japan Seminar on Dielectric and Piezoelectric Ceramics, Welches, OR (2009).
23. G.L. Brennecka, J.S. Wheeler, C.M. Parish, B.A. Tuttle, A. Gin, and J.G. Ekerdt, "Electrical Ceramics: Functional at Fifty (and Fewer) Nanometers," Presented at the 110th Annual Meeting of the American Ceramic Society, combined with MS&T'08, Pittsburgh, PA (2008).
24. G.L. Brennecka and D.A. Payne, "Tantalizing Ceramics: Elucidation of Unusual Behavior in Ta₂O₅," Presented at the 109th Annual Meeting of the American Ceramic Society, combined with MS&T'07, Detroit, MI (2007).
25. G.L. Brennecka, B.A. Tuttle, C.M. Parish, L.N. Brewer, B.B. McKenzie, and M.A. Rodriguez, "Fabrication of Ultrathin Integrated Multilayer Capacitors by Chemical Solution Deposition," Presented at the 13th US-Japan Seminar on Dielectric and Piezoelectric Ceramics, Awaji City, Hyogo, Japan (2007).

Invited Seminars

1. G.L. Brennecka, "Function from frustration: Taking advantage of complexity, heterogeneity, and nonlinearity in electrical ceramics," Student-selected invited seminar for the Materials Engineering department at Purdue University, West Lafayette, IN (2016).
2. G.L. Brennecka, "Function from frustration: Taking advantage of complexity, heterogeneity, and nonlinearity in electrical ceramics," Invited seminar for the MSE department at Missouri S&T, Rolla, MO (2016)
3. G.L. Brennecka, "Ferroelectric Opening Switches: the promises and challenges of non-linearity," Invited seminar as part of the Power on Demand series at Sandia National Laboratories, Albuquerque, NM (2016).
4. G.L. Brennecka, "Function from frustration: Taking advantage of complexity, heterogeneity, and nonlinearity in electrical ceramics", Invited seminar in the department of Mechanical Engineering, West Virginia University (2016).
5. G.L. Brennecka, "Chemical heterogeneity in electroceramics: the good, the bad, and the difficult to characterize!", Invited seminar at the Rocky Mountain section of ASM, Golden, CO (2016).
6. G.L. Brennecka, "Chemical heterogeneity in electroceramics: the good, the bad, and the difficult to characterize!", Invited seminar at the National Renewable Energy Laboratory, Golden, CO (2015).
7. G.L. Brennecka, J.F. Ihlefeld, and H.J. Brown-Shaklee, "Chemical heterogeneity in electroceramics: the good, the bad, and the difficult to characterize!", Presented as part of the Materials Science and Engineering Seminar Series at Drexel University, Philadelphia, PA (2015).
8. G.L. Brennecka, J.F. Ihlefeld, and H.J. Brown-Shaklee, "Chemical heterogeneity in electroceramics: the good, the bad, and the difficult to characterize!", Presented as part of the Materials Science and Engineering Seminar Series at Boise State University, Boise, ID (2015).
9. G.L. Brennecka, "Advances in Solution-Derived Piezoelectric Thin Films," Presented as part of the Mechanical Engineering Seminar Series at the Colorado School of Mines, Golden, CO (2014).

10. G.L. Brennecka, H.J. Brown-Shaklee, N. Raengthon, N. Triamnak, J.J. Borchardt, M.A. Blea-Kirby, and D.P. Cann, "High Reliability Ceramic Capacitors based on Temperature- and Voltage-Stable Relaxor Dielectrics," Presented as part of the Chemical Engineering Department Seminar Series at New Mexico State University, Las Cruces, NM (2013).
11. G.L. Brennecka, J.F. Ihlefeld, K. Nittala, J.L. Jones, M.C. George, L.D. Williamson, and P.F. Nealey, "Chemical, Phase, and Interface Effects in Solution-Based Fabrication of Continuous and Nanopatterned Thin Film Ferroelectrics," Presented as part of the Materials Science and Engineering Department Seminar Series at the New Mexico Institute of Mining and Technology, Socorro, NM (2012).
12. G.L. Brennecka, "Patterning and Integration of Ferroelectrics and other Functional Nanostructures," Presented as part of the University of Illinois at Urbana-Champaign Materials Science and Engineering Department Colloquium, Urbana, IL (2010).
13. G.L. Brennecka, "Patterning and Integration of Ferroelectrics and other Functional Nanostructures," Presented as part of the Clemson University Chemical Engineering Department Seminar Series, Clemson, SC (2010).
14. G.L. Brennecka, "Combined Lithography for Versatile Nanoscale Patterning and Integration," Presented as a Seminar to the University of Houston Chemical and Biological Engineering Department, Houston, TX (2010).
15. G.L. Brennecka, "Frontiers in Ceramics: You *can* teach old rocks new tricks," Presented to the Condensed Matter and Materials Research Committee of the **National Research Council**, Washington, DC (2010).
16. G.L. Brennecka, "Continuous and Nanopatterned Ferroelectric Thin Films: Big Impact from Small Science", Seminar presented to the Materials Science and Engineering Department at the University of Florida, Gainesville, FL (2009).
17. G.L. Brennecka, "Functional Solution-Derived Nanoscale Electronic Oxides," Invited Seminar at the NASA Glenn Research Center in Cleveland, OH (2008).
18. G.L. Brennecka, "Electroceramic Solutions: From Nanometers to MegaAmperes," Invited Seminar for the Materials Science and Engineering Department at Missouri S&T, Rolla, MO (2008).