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Education

Technical University Darmstadt, Germany	Materials Science	Diploma, 2003
Technical University Darmstadt, Germany	Materials Science	Ph.D., 2006

Professional Experience

2010–p	Staff scientist, Center for Nanophase Materials Sciences, ORNL
2009–2010	Feodor Lynen Fellow, Center for Nanophase Materials Sciences, ORNL
2007–2009	Feodor Lynen Fellow, Department of Physics, University of California, Berkeley
2003–2007	Research Associate, Non-metallic Inorganic Materials, Institute of Materials Science, Technical University Darmstadt, Germany

Professional and Synergistic Activities

- Member at-large of the Center for Nanophase Materials Sciences User Executive Committee at Oak Ridge National Laboratory.
- Reviewer for eight peer-reviewed journals.
- Symposium organizer for Spring MRS 2012 (CCC: Local probing techniques and in-situ measurements in material sciences).
- Co-editor of the theme topic “Scanning Probes of Local Phenomena in Energy Related Materials” in MRS Bulletin to be published 2012.

Honors and Awards

08/2011	Microscopy Today Innovation Award for the development of Electrochemical Strain Microscopy.
04/2011	Department of Energy Early Career Research Award for “Spatially resolved ionic diffusion and electrochemical reactions in solids - a biased view at lithium ion batteries”.
2007-2011	Feodor Lynen Fellowship of the Alexander von Humboldt foundation.
10/2010	Roland B. Snow award of the American Ceramic Society for the ceramograph “Tracking Li-ion motion on the nanoscale”.

Publications

Over 30 publications. Full publication list follows CV.

Research Synopsis

1. *Local ionic transport in energy storage materials.*
Investigation Li-ion mobility in battery materials on the nanoscale and its role in battery charging and fading using advanced Scanning Probe Techniques.
2. *Topological defects in ferroelectrics.*
Deterministic control of ferroelectric switching is used to investigate new topological defects like the vortex domain and its coupling with other order parameters in multiferroic thin films for new device concepts.
3. *Nanoscale ferroelectric switching in thin films.*
Investigation of domain switching and relaxation in ferroelectric and multiferroic thin films using scanning probe techniques were conducted. The main focuses were the tunability of nano-domain stability in Pb(Zr,Ti)O₃ thin films and domain manipulation in BiFeO₃ using the PFM tip and different electrode configurations.

4. *Degradation mechanisms of actuator materials.*

The origin and consequences of aging and fatigue under different electrical loads of ferroelectric ceramics were studied. Models for fatigue were developed to explain the measured characteristics of fatigued samples.

Graduate and Postdoc Advisors:

Graduate Advisor: Prof. J. Rödel (Technical University Darmstadt)

Postdoc Advisors: Prof. R. Ramesh (University of California, Berkeley)
S. V. Kalinin (Oak Ridge National Laboratory)

PUBLICATIONS

Nina Balke, Ph.D.

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1. S. V. Kalinin, N. Balke, S. Jesse, A. Tselev, A. Kumar, T. M. Arruda, S. Guo, and R. Proksch, "Li-ion dynamics and reactivity on the nanoscale", **Materials Today** 14, 548-558 (2011).
2. N. Balke, B. Winchester, W. Ren, Y. H. Chu, A. N. Morozovska, E. A. Eliseev, M. Huijben, R. K. Vasudevan, P. Maksymovych, J. Britson, S. Jesse, I. Kornev, R. Ramesh, L. Bellaiche, L. Q. Chen, and S. V. Kalinin, "Enhanced electric conductivity at ferroelectric vortex cores in BiFeO₃", **Nature Physics**, doi:10.1038/nphys2132 (2011).
3. H. Chang, S. V. Kalinin, S. Yang, P. Yu, S. Bhattacharya, P. P. Wu, N. Balke, S. Jesse, L. Q. Chen, R. Ramesh, S. J. Pennycook, and A. Y. Borisevich, "Watching domains grow: In-situ studies of polarization switching by combined scanning probe and scanning transmission electron microscopy", **J. Appl. Phys.** 110, 052014 (2011).
4. S. V. Kalinin, S. Jesse, A. Tselev, A. P. Baddorf, and N. Balke, "The role of electrochemical phenomena in scanning probe microscopy of ferroelectric thin films", **ACS Nano** 5, 5683-5691 (2011).
5. D.-W. Chung, N. Balke, S. V. Kalinin, and R. E. García, "Virtual electrochemical strain microscopy of polycrystalline LiCoO₂ films", **J. Electrochem. Soc.** 158, A1083-A1089 (2011).
6. J. Y. Jo, P. Chen, R. J. Sichel, S.-H. Baek, R. T. Smith, N. Balke, S. V. Kalinin, M. V. Holt, J. Maser, K. Evans-Lutterodt, C.-B. Eom, and P. G. Evans, "Structural consequences of ferroelectric nanolithography", **Nano Letters** dx.doi.org/10.1021/nl2009873 (2011).
7. S. Guo, S. Jesse, S. Kalnaus, N. Balke, C. Daniel, and S. V. Kalinin, "Direct mapping of ion diffusion times on LiCoO₂ surfaces with nanometer resolution", **J. Electrochem. Soc.** 158, A982-A990 (2011).
8. R. K. Vasudevan, Y.-C. Chen, H.-H. Tai, N. Balke, P. Wu, S. Bhattacharya, L. Q. Chen, Y.-H. Chu, I.-N. Lin, S. V. Kalinin, and V. Nagarajan, "Exploring topological defects in epitaxial BiFeO₃ thin films", **ACS Nano** 5, 879-887 (2011).
9. N. Balke, S. Jesse, Y. Kim, L. Adamczyk, I. Ivanov, N. J. Dudney, S. V. Kalinin, "Decoupling electrochemical reaction and diffusion processes in ionically-conductive solids on the nanometer scale", **ACS Nano** 4, 7349-7357 (2010).
10. S. V. Kalinin and N. Balke, "Local electrochemical functionality in energy storage materials and devices by scanning probe microscopies: status and perspectives", **Adv. Mater.** 22, E193-E209 (2010).
11. N. Balke, S. Jesse, A. N. Morozovska, E. Eliseev, D. W. Chung, Y. Kim, L. Adamczyk, R. E. García, N. Dudney, and S.V. Kalinin, "Nanoscale mapping of ion diffusion in a lithium-ion battery cathode", **Nat. Nanotech.** 5, 749-754 (2010).
12. N. Balke, S. Jesse, Y. Kim, L. Adamczyk, A. Tselev, I. N. Ivanov, N. J. Dudney, and S.V. Kalinin, "Real space mapping of Li-ion transport in amorphous Si anodes with nanometer resolution", **Nano Lett.** 10, 3420-3425 (2010).
13. N. Balke, M. Gajek, A. K. Tagantsev, L. W. Martin, Y.-H. Chu, R. Ramesh, and S. V. Kalinin, "Direct observation of capacitor switching using planar electrodes", **Adv. Funct. Mater.** 20, 3466-3475 (2010).
14. A. N. Morozovska, E. A. Eliseev, N. Balke, and S. V. Kalinin, "Local probing of ionic diffusion by electrochemical strain microscopy: spatial resolution and signal formation mechanisms", **J. Appl. Phys.** 108, 053712 (2010).

15. H. W. Jang, A. Kumar, S. Denev, M. D. Biegalski, P. Maksymovych, C. W. Bark, C. T. Nelson, C. M. Folkman, S. H. Baek, N. Balke, C. M. Brooks, D. A. Tenne, D. G. Schlom, L. Q. Chen, X. Q. Pan, S. V. Kalinin, V. Gopalan, and C. B. Eom, "Ferroelectricity in strain-free SrTiO₃ thin films", **Phys. Rev. Lett.** 104, 197601 (2010).
16. S. V. Kalinin, B. J. Rodriguez, A. Y. Borisevich, A. P. Baddorf, N. Balke, H. J. Chang, L. Q. Chen, S. Choudhury, S. Jesse, P. Maksymovych, M. P. Nikiforov, and S. J. Pennycook, "Defect-mediated polarization switching in ferroelectrics and related materials: from mesoscopic mechanisms to atomistic control", **Adv. Mater.** 22, 314-322 (2010).
17. N. Balke, S. Choudhury, S. Jesse, M. Huijben, Y. H. Chu, A. P. Baddorf, L. Q. Chen, R. Ramesh, and S.V. Kalinin, "Deterministic control of ferroelastic switching in multiferroic materials", **Nat. Nanotechnol.** 4, 868 (2009).
18. P. Maksymovych, N. Balke, S. Jesse, M. Huijben, R. Ramesh, A. P. Baddorf, and S. V. Kalinin, "Defect-induced asymmetry of local hysteresis loops on BiFeO₃ surfaces", **J. Mater. Sci.** 44, 5095-5101 (2009).
19. N. Balke, I. Bdikin, S. V. Kalinin, and A. Kholkin, "Electromechanical imaging and spectroscopy of ferroelectric and piezoelectric materials: state-of-the art and prospects for the future", **J. Am. Ceram. Soc.** 92, 1629 (2009).
20. N. Balke, T. Granzow, and J. Rödel, "Degradation of lead-zirconate-titanate ceramics under different DC loads", **J. Appl. Phys.** 105, 104105 (2009).
21. C.-H. Yang, J. Seidel, S. Y. Kim, P. Rossen, P. Yu, M. Gajek, Y. H. Chu, L. W. Martin, M. B. Holcomb, Q. He, P. Maksymovych, N. Balke, S. V. Kalinin, A. P. Baddorf, S. R. Basu, M. L. Scullin, and R. Ramesh, "Electric modulation of conduction in multiferroic Ca-doped BiFeO₃ films", **Nat. Mater.** 8, 485 (2009).
22. J. Seidel, L. W. Martin, Q. He, Q. Zhang, Y.-H. Chu, A. Rother, M. E. Hawkridge, P. Maksymovych, P. Yu, M. Gajek, N. Balke, S. V. Kalinin, S. Gemming, F. Wang, G. Catalan, J. F. Scott, N. A. Spaldin, J. Orenstein, and R. Ramesh, "Conduction at domain walls in oxide multiferroics", **Nat. Mater.** 8, 229 (2009).
23. L. W. Martin, S. P. Crane, Y.-H. Chu, M. B. Holcomb, M. Gajek, M. Huijben, C.-H. Yang, N. Balke, R. Ramesh, "Multiferroics and magnetoelectrics: thin films and nanostructures", **J. Phys.: Condens. Matter** 20, 434220 (2008).
24. N. Balke, T. Granzow, and J. Rödel, "Current-voltage characteristics for PZT bulk ceramics", **J. Appl. Phys.** 104, 054120 (2008).
25. Y.-H. Chu, L. W. Martin, M. B. Holcomb, M. Gajek, S.-J. Han, Q. He, N. Balke, C.-H. Yang, D. Lee, W. Hu, Q. Zhan, P.-L. Yang, A. Fraile-Rodriguez, A. Scholl, S. X. Wang, and R. Ramesh, "Electric-field control of local ferromagnetism using a magnetoelectric multiferroic", **Nat. Mater.** 7, 478 (2008).
26. N. Balke, H. Kungl, T. Granzow, D. C. Lupascu, M. J. Hoffmann, and J. Rödel, "Bipolar fatigue caused by field screening in Pb(Zr,Ti)O₃ ceramics", **J. Am. Ceram. Soc.** 90, 3869-3874 (2007).
27. N. Balke, D. C. Lupascu, T. Granzow, J. Rödel, "Fatigue of lead zirconate titanate ceramics II: sesquipolar loading", **J. Am. Ceram. Soc.** 90, 1088-1093 (2007).
28. N. Balke, D. C. Lupascu, T. Granzow, J. Rödel, "Fatigue of lead zirconate titanate ceramics I: unipolar and DC loading", **J. Am. Ceram. Soc.** 90, 1081-1087 (2007).
29. N. Balke, D. C. Lupascu, T. Blair, A. Gruverman, "Thickness profiles through fatigued bulk lead zirconate titanate", **J. Appl. Phys.** 100, 114117 (2006).
30. D. C. Lupascu, Y. A. Genenko, N. Balke, "Aging in ferroelectrics", **J. Am. Ceram. Soc.** 89, 224-9 (2006).
31. T. Granzow, N. Balke, D. C. Lupascu, J. Rödel, "Evolution of a stable polarization state in lead zirconate titanate ceramics by repeated partial switching", **Appl. Phys. Lett.** 87, 212901 (2005).