

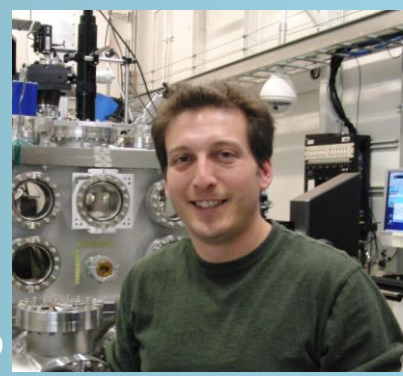
MARTIN HOLT

Scientist, Nanoscience

X-ray Microscopy Group

Center for Nanoscale Materials
Building 440, Room A139
Phone: 630-252-5180
Fax: 630-252-0439
E-mail: mvholt@anl.gov

Argonne National Laboratory
9700 S Cass Ave., Argonne, IL 60439



Education

Ph. D. Physics, University of Illinois Urbana-Champaign
B. A. Physics and Mathematics, Rice University

Awards and honors

- R&D 100 Award – The Hard X-ray Nanoprobe (2009)

Research interests

- Fundamental physics of active materials at the nanoscale – controlling correlated material response through scaling, engineered interfaces, heterostructures, and environments
- Coherent diffraction imaging and Bragg ptychography for nanoscale structural studies
- Frontier scattering tools for synchrotron microscopy – inelastic and correlative imaging

Professional Experience

Argonne National Laboratory - Center for Nanoscale Materials (CNM)
Scientist, Nanoscience

2009-present

- Innovation, design, and implementation of frontier techniques for nanoscale imaging of materials properties using hard x-ray microscopy
 - Demonstrated hard x-ray imaging of structural domains at landmark 6nm spatial resolution
 - Observed large wave-vector phonon confinement in 10nm semiconductor membranes
- Scientific contact for CNM x-ray diffraction microscopy user projects - collaboratively guiding all phases of proposals, project planning, data acquisition, data analysis and publication.

Argonne National Laboratory –Center for Nanoscale Materials (CNM)
Assistant Physicist

2004-2009

- Co-principal investigator of the R&D 100 award-winning Hard X-ray Nanoprobe Beamline – design, construction, commissioning, and acceptance (\$13.6 million project)
- Development of a non-goniometer-based approach to hard x-ray nanoscale strain mapping at a strain sensitivity of $dc/c \sim 10^{-5}$ at a spatial resolution of $\sim 25\text{nm}$

McGill University – Department of Physics
Post-Doctoral Fellow

2002-2004

- Observed geometrical pinning of strain fields near ferroelectric domain boundaries
- Quantified separation of critical fluctuations from static disorder in displacive phase transitions

University Illinois Urbana-Champaign – Department of Physics
Graduate Research Assistant

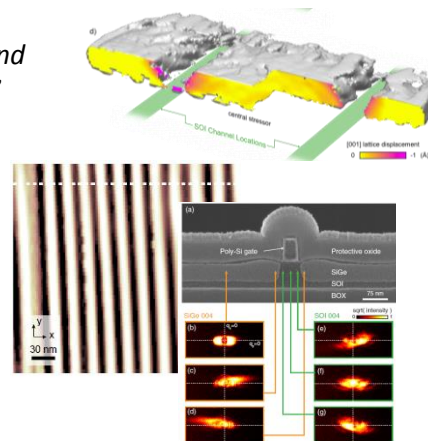
1998-2002

- Determination of phonon dispersions in elemental systems via hard x-ray thermal diffuse scattering
- Observed phonon softening and renormalization near displacive charge-density-wave transitions

Selected Publications

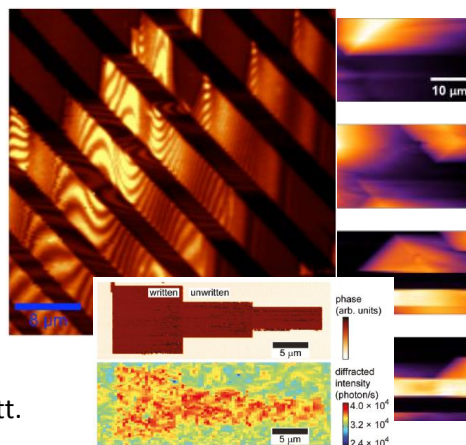
Coherent Bragg diffraction imaging of ferroelectric and semiconductor heterostructures

1. **M. V. Holt**, S. O. Hruszkewycz, C. E. Murray, J. R. Holt, D. M. Paskiewicz, and P. H. Fuoss. "Strain imaging of nanoscale semiconductor heterostructures with X-ray Bragg Projection Ptychography." *Phys. Rev. Lett.* **112**, 165502 (2014)
2. S. O. Hruszkewycz, **M. V. Holt**, J. Maser, C. E. Murray, M. J. Highland, C. M. Folkman and P. H. Fuoss. "Coherent Bragg nanodiffraction at the hard X-ray Nanoprobe beamline." *Phil. Trans. R. Soc. A* **372**, 20130118 (2014)
3. S. O. Hruszkewycz, M. J. Highland, **M. V. Holt**, D. Kim, C. M. Folkman et al. "Imaging local polarization in ferroelectric thin films by coherent x-ray Bragg projection ptychography" *Phys. Rev. Lett.* **110**, 177601 (2013)
4. S. O. Hruszkewycz, **M. V. Holt**, C. E. Murray, J. Bruley, J. Holt et al. "Quantitative nanoscale imaging of lattice distortions in epitaxial semiconductor heterostructures using nanofocused x-ray Bragg projection ptychography." *Nano Lett.* **12**(10): 5148-5154 (2012)
5. S. O. Hruszkewycz, **M. V. Holt**, A. Tripathi, J. Maser, and P. H. Fuoss. "Framework for three-dimensional coherent diffraction imaging by focused beam x-ray Bragg ptychography" *Optics Letters*, Vol. **36**, Issue 12, pp. 2227-2229 (2011)



Nanoscale hard x-ray diffraction microscopy for in-situ structural imaging

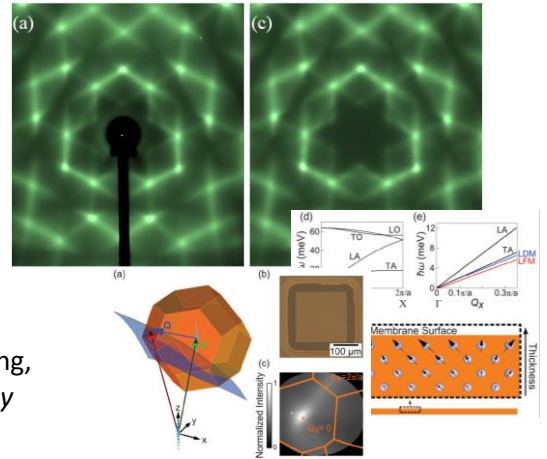
6. T. A. Lummen, Y. Gu, J. Wang, S. lei, F. Xue, A. Kumar, A. T. Barnes, E. Barnes, S. Denev, A. Belianinov, **M. V. Holt**, A. N. Morozovska, S. V. Kalinin, L. Q. Chen, V. Gopalan. "Thermotropic phase boundaries in classic ferroelectrics." *Nature Communications* **5**, 3172 (2014)
7. D. M. Paskiewicz, D. E. Savage, **M. V. Holt**, P. G. Evans, M. G. Lagally. "Nanomembrane-based materials for Group IV semiconductor quantum electronics." *Scientific Reports* **4**, 4218 (2014)
8. **M. V. Holt**, R. Harder, R. Winarski, and V. Rose. "Nanoscale Hard X-ray Microscopy Methods for Materials Studies." *Annual Review of Material Research* **43**:3.1-3.29 (2013)
9. J. A. Klug, **M. V. Holt**, R. N. Premnath, A. Joshi-Imre, S. Hong, et al. "Elastic relaxation and correlation of local strain gradients with ferroelectric domains in (001) BiFeO3 nanostructures", *Appl. Phys. Lett.* **99**, 052902 (2011)
10. S. O. Hruszkewycz, C. M. Folkman, M. J. Highland, **M. V. Holt** et al. "X-ray nanodiffraction of tilted domains in a poled epitaxial BiFeO3 thin film." *Appl. Phys. Lett.* **99**:232903 (2011)
11. C. E. Murray, A. Ying, S. M. Polvino, I. C. Noyan, **M. V. Holt**, and J. Maser, "Nanoscale silicon-on-insulator deformation induced by stressed liner structures" *J. Appl. Phys.* **109**, 083543 (2011);
12. 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 Lett.* **11**, 3080–3084 (2011)



13. M. M. Qazilbash, A. Tripathi, A. A. Schafgans, Bong-Jun Kim, Hyun-Tak Kim, Zhonghou Cai, **M. V. Holt**, J. M. Maser, F. Keilmann, O. G. Shpyrko, and D. N. Basov, "Nanoscale imaging of the electronic and structural transitions in vanadium dioxide" *Physical Review B* **83**, 165108 (2011)
14. **M. V. Holt**, Kh. Hassani, and M. Sutton "Microstructure of ferroelectric domains in BaTiO₃ observed via X-ray micro-diffraction." *Phys. Rev. Lett.* **95**, 085504 (2005)

Phonons and fluctuations in engineered and phase active materials

15. G. Gopalakrishnan, **M. V. Holt**, K. M McElhinny, J. W Spalenka, D. A. Czapslewski, T. U. Schulli, and P. G. Evans. "Thermal diffuse scattering as a probe of large-wave-vector phonons in Silicon nanostructures." *Phys. Rev. Lett.* **110**, 205503 (2013)
16. H. Hong, R. Xu, A. Alatas, **M. V. Holt**, T.-C. Chiang. "Central peak and narrow component in x-ray scattering measurements near the displacive phase transition in SrTiO₃." *Phys. Rev. B* **78** (10), 104121-1-104121-4 (2008)
17. **M. V. Holt**, M. Sutton, P. Zschack, H. Hong, and T.-C. Chiang, "Dynamic fluctuations and static speckle from critical x-ray scattering in SrTiO₃" *Phys. Rev. Lett.* **98**, 065501 (2007)
18. **M. V. Holt**, P. Czoschke, H. Hong, P. Zschack, H. K. Birnbaum, T. Chiang. "Phonon dispersions in niobium determined by x-ray transmission scattering." *Phys. Rev. B* **66**, 64303 (2002)
19. **M. V. Holt**, P. Zschack, H. Hong, M. Y. Chou, T.-C. Chiang "X-ray studies of phonon softening in TiSe₂." *Phys. Rev. Lett.* **86**, 3799 (2001)
20. **M. V. Holt**, Z. Wu, H. Hong, P. Zschack, P. Jemian, et al. "Determination of phonon dispersions from x-ray transmission scattering: The example of silicon." *Phys. Rev. Lett.* **83**, 3317 (1999)



-C.

Patents

- No. 7,331,714 A *optoelectronic structure for a multifunctional hard x-ray Nanoprobe instrument.* D. Shu, J. Maser, B. Lai, S. Vogt, **M. Holt**, C. Preissner, R. P. Winarski, and G. B. Stephenson