

De-Liang Bao

Postdoctoral Scholar, Condensed Matter Physics
Department of Physics and Astronomy, Vanderbilt University



CONTACT INFORMATION

Email: dl.bao@vanderbilt.edu

EDUCATION

- Sep. 2007 – Jul. 2011: Bachelor, Shandong Normal University, Jinan, China
- Sep. 2011 – Jul. 2014: Master, Shandong Normal University, Jinan, China
- Sep. 2014 – Jun. 2018: Ph.D, University of Chinese Academy of Sciences, Beijing, China
- Oct. 2017 – Apr. 2018: Exchange Student, Vanderbilt University, Nashville, TN, U.S.

EXPERIENCE

- Jun. 2018 – Jun. 2022: Postdoctoral Fellow, Institute of Physics, Chinese Academy of Sciences
- Dec. 2018 – present: Postdoctoral Fellow, Vanderbilt University
- Mar. 14 2022: Session A65 Chair, APS March Meeting 2022, Chicago
- Mar. 07 2023: Session K64 Chair, APS March Meeting 2023, Las Vegas

RESEARCH DESCRIPTION

- **Phononics in complex materials:** Phonon-mediate properties (phonon polaritons, thermal conductivity) in complex/superlattice materials containing point defects or interfaces.
- **Low-dimensional materials:** The structure exploration, growth mechanisms, novel electronic structures (e.g., anisotropic Dirac Cones), multiferroicity (e.g., magnetism-ferroelectricity correlation) in organic/inorganic two-dimensional materials; Twisted one-dimensional nanomaterials.
- **Atomic/molecular properties on surfaces:** The self-assembly structures, the reaction (polymerization, metalation) mechanisms, and dynamic behaviors (hydrogen-atoms transportation).

HONORS

2022 Post-Doctoral Travel Award, American Physics Society (APS) Division of Materials Physics (DMP)
2016 President Recognition Awards in the Institute of Physics, Chinese Academy of Sciences
2015 President Recognition Awards in the Institute of Physics, Chinese Academy of Sciences
2014 Outstanding graduate in Shandong Province, China

FUNDING

2018 China Postdoctoral Science Foundation (Grant 2018M641511)
2022 Post-Doctoral Travel Award (\$1200), APS Division of Materials Physics (DMP)

PUBLICATIONS (# Co-first author) (* First theory author) (Chronological order)

- (1) M. Xu, **D.-L. Bao**#, A. Li, and *et al.* Single-atom vibrational spectroscopy with chemical-bonding sensitivity. *Nature Materials* 22, 612–618 (2023)
- (2) E. R. Hoglund, **D.-L. Bao**#, A. O'Hara, and *et. al.* Direct visualization of localized vibrations at complex grain boundaries. *Advanced Materials* 2208920 (2023)
- (3) D. Wang, **D.-L. Bao**#, C. T. Wang, and *et. al.* Twisted bilayer zigzag-graphene nanoribbons with stacking offset-tunable edge states. *Nature Communications* 14, 1018 (2023)
- (4) **D.-L. Bao**, A. O'Hara, S. Du, S. T. Pantelides. Tunable, ferroelectricity-inducing, spin-spiral magnetic ordering in monolayer FeOCl. *Nano Letters* 22, 3598–3603 (2022) (Highlighted by Vanderbilt Institute of Nanoscale Science and Engineering (VINSE) Spotlight Publications: [link](#))
- (5) E. R. Hoglund, **D.-L. Bao***, A. O'Hara, and *et. al.* Emergent interface vibrational structure of oxide superlattices. *Nature* 601, 556-561 (2022)

- (6) E. R. Hoglund, J. Hachtel, **D.-L. Bao***, and *et. al.* STEM Imaging, monochromated EELS, and theory of natural and artificial superlattices. *Microscopy and Microanalysis* 28, 1682-1683 (2022)
- (7) Q. Zheng, L. Huang, **D.-L. Bao***, and *et. al.* Substrate tuned reconstructed polymerization of naphthalocyanine on Ag (110). *Chinese Physics B* 31, 018202 (2022)
- (8) D. Xiao, **D.-L. Bao***, X. Liang, and *et. al.* Experimental and theoretical investigation of the control and balance of active sites on oxygen plasma-functionalized MoSe₂ nanosheets for efficient hydrogen evolution reaction. *Applied Catalysis B: Environmental* 288, 119983 (2021)
- (9) R. Wu, **D.-L. Bao#**, L. Yan, and *et. al.* Construction of poly-naphthalocyanine linked by [4]-radialene-like structures on silver surfaces. *Nano Research* 1-6 (2021)
- (10) J. Lu, G. Niu, **D.-L. Bao***, and *et. al.* Controllable fabrication and photocatalytic performance of nanoscale single-layer MoSe₂ islands with substantial edges on an Ag(111) substrate. *Nanoscale*. (2021)
- (11) W.-H. Dong, **D.-L. Bao#**, J.-T. Sun, and *et. al.* Manipulation of Dirac fermions in nanochain-structured graphene. *Chinese Physics Letters* 38, 097101 (2021)
- (12) E. R. Hoglund, J. Hachtel, **D.-L. Bao***, and *et. al.* Nanoscale STEM/EELS and theory investigations of vibronic properties of superlattices. *Microscopy and Microanalysis* 27 (2021)
- (13) H. Chen, **D.-L. Bao#**, D. Wang, and *et. al.* Fabrication and manipulation of nanosized graphene homojunction with atomically-controlled boundaries. *Nano Research* 1-6 (2020)
- (14) R. Wu, **D.-L. Bao#**, L. Yan, and *et. al.* Direct visualization of hydrogen-transfer intermediate states by scanning tunneling microscopy. *The Journal of Physical Chemistry Letters* 11, 1536-1541 (2020)
- (15) L. Guo, Y. Wang, **D.-L. Bao#**, and *et. al.* On-surface synthesis of size- and shape-controlled two-dimensional Aun nanoclusters using a flexible fullerene molecular template. *Nanoscale* 23, 21657 (2020)
- (16) D. Xiao, Q. Ruan, **D.-L. Bao***, and *et. al.* Effects of ion energy and density on the plasma etching-induced surface area, edge electrical field, and multivacancies in MoSe₂ nanosheets for enhancement of the hydrogen evolution reaction. *Small* 2001470 (2020)
- (17) X.-L. Zhang, **D.-L. Bao**, and *et. al.* Anisotropic high carrier mobilities of one-third-hydrogenated group-V elemental monolayers. *The Journal of Physical Chemistry C* 124, 12628-12635 (2020)
- (18) K. Qian, L. Gao, X. Chen, H. Li, S. Zhang, X.-L. Zhang, S. Yu, J. Yan, **D.-L. Bao**, and *et. al.* Air-stable monolayer Cu₂Se exhibits a purely thermal structural phase transition. *Advanced Materials* 1908314 (2020)
- (19) H.-H. Jia, **D.-L. Bao**, Y.-Y. Zhang, and *et. al.* Structural and thermal stabilities of Au@Ag core-shell nanoparticles and their arrays: A molecular dynamics simulation, *Chinese Physics B* 29, 048701 (2020)
- (20) H. Chen, X.-L. Zhang, Y.-Y. Zhang, D. Wang, **D.-L. Bao**, and *et. al.* Atomically precise, custom-design origami graphene nanostructures. *Science* 365, 1036-1040 (2019)
- (21) J. P. Bonacum, A. O'Hara, **D.-L. Bao**, and *et. al.* Atomic-resolution visualization and doping effects of complex structures in intercalated bilayer graphene. *Physical Review Materials* 3, 064004 (2019)
- (22) Z.-L. Liu, B. Lei, Z.-L. Zhu, L. Tao, J. Qi, **D.-L. Bao**, and *et. al.* Spontaneous formation of 1D pattern in monolayer VSe₂ with dispersive adsorption of Pt atoms for HER catalysis, *Nano Letters* 19, 4897-4903 (2019)
- (23) R. Wu, L. Yan, **D.-L. Bao***, and *et. al.* Self-assembly evolution of metal-free naphthalocyanine molecules on Ag (111) at the submonolayer coverage, *The Journal of Physical Chemistry C* 123, 7202-7208(2019).
- (24) H. Guo, X. Wang, **D.-L. Bao***, and *et. al.* Fabrication of large-scale graphene/2D-germanium heterostructure by intercalation. *Chinese Physics B* 28, 078103 (2019)
- (25) **D.-L. Bao**, Y.-Y. Zhang, S. Du, and *et. al.*, Barrierless on-surface metal incorporation in phthalocyanine-based molecules, *The Journal of Physical Chemistry C*, 122, 6678-6683(2018).
- (26) H. Chen, **D.-L. Bao#**, D. Wang, and *et. al.* Fabrication of millimeter-scale, single-crystal one-third-hydrogenated graphene with anisotropic electronic properties, *Advanced Materials* 30, 1801838(2018).

- (27) Q. Zhong, D. Ebeling, J. Tashakert, Y. Gao, **D.-L. Bao**, and *et. al.* A. Schirmeisen. Symmetry breakdown of 4, 4''-diamino-p-terphenyl on a Cu (111) surface by lattice mismatch, *Nature Communications* 9, 3277(2018)
- (28) J. Lu, Z. Ruan, Y. Guan, **D.-L. Bao***, and *et. al.* Controllable density of atomic bromine in a two-dimensional hydrogen bond network, *The Journal of Physical Chemistry C* 122, 25681-25684(2018).
- (29) D. Kaya, **D.-L. Bao#**, R. E. Palmer, and *et. al.*, Tip-triggered thermal cascade manipulation of magic number gold–fullerene clusters in the scanning tunneling microscope, *Nano Letters* 17, 6171-6176(2017).
- (30) J. C. Lu, **D.-L. Bao#**, K. Qian, and *et. al.* Identifying and visualizing the edge terminations of single-layer MoSe2 island epitaxially grown on Au(111), *ACS Nano*, 11, 1689-1695(2017).
- (31) J. Ren, **D.-L. Bao#**, L. Dong, and *et. al.* Lattice-directed construction of metal-organic molecular wires of pentacene on the Au(110) surface, *The Journal of Physical Chemistry C*, 121, 21650-21657(2017).
- (32) J. C. Lu, **D.-L. Bao#**, H. Dong, and *et. al.* Construction of two-dimensional chiral networks through atomic bromine on surfaces. *The Journal of Physical Chemistry Letters* 8, 326-331(2017).
- (33) X. Lin, J. C. Lu, Y. Shao, Y. Y. Zhang, X. Wu, J. B. Pan, L. Gao, S. Y. Zhu, K. Qian, Y. F. Zhang, **D. -L. Bao**, and *et. al.* Intrinsically patterned two-dimensional materials for selective adsorption of molecules and nanoclusters, *Nature Materials* 16, 717-722(2017).
- (34) H. Chen, T. Pope, Z.-Y. Wu, D. Wang, L. Tao, **D. -L. Bao**, and *et. al.* Evidence for ultralow-energy vibrations in large organic molecules, *Nano Letters* 8, 4929-4933(2017).
- (35) J. H. Ren, **D. -L. Bao***, L. Dong, and *et. al.* Thermo-controllable self-assembled structures of single-layer 4,4''-diamino-p-terphenyl molecules on Au (110), *Chinese Physics B* 26, 086801(2017). (Cover story, Highlights in 2017)
- (36) Y.-C. Xie, M. R. Fard, D. Kaya, **D.-L. Bao#**, and *et. al.* Site-specific assembly of fullerene nanorings guided by two-dimensional gold clusters. *The Journal of Physical Chemistry C*, 120, 10975-10981(2016).
- (37) J. Li, C. M. Shen, Y. D. Que, Y. Tian, L. L. Jiang, **D.-L. Bao**, and *et. al.* Copper vapor-assisted growth of hexagonal graphene domains on silica islands, *Applied Physics Letters* 109, 023106 (2016).
- (38) R. T. Wu, L. H. Yan, Y. F. Zhang, J. H. Ren, **D.-L. Bao**, and *et. al.* Self-assembled patterns and Young's modulus of single-layer naphthalocyanine molecules on Ag(111), *The Journal of Physical Chemistry C* 119, 8208-8212 (2015).
- (39) L. H. Yan, R. T. Wu, **D.-L. Bao#**, and *et. al.* Adsorption behavior of Fe atoms on a naphthalocyanine monolayer on Ag(111) surface, *Chinese Physics B* 24, 076802(2015).
- (40) **D.-L. Bao**, R. Liu, J.-C. Leng, and *et. al.* Theoretical study on mechanical and electron-transport properties of conjugated molecular junctions with carboxylic or methyl sulfide links, *Physics Letters A*, 378, 1290-1295(2014).
- (41) R. Liu, **D.-L. Bao**, Y. Jiao, and *et. al.* Study on force sensitivity of electronic transport properties of 1, 4-butanedithiol molecular device, *Acta Physica Sinica* 63, 068501(2014).
- (42) Y. Song, **D.-L. Bao**, Z. Xie, and *et. al.* Wang, Obvious variation of rectification behaviors induced by isomeric anchoring groups for dipyrimidinyl–diphenyl molecular junctions, *Physics Letters A* 377, 3228-3234(2013).

PATENT

"Proton transport membranes and methods of making and use thereof", US20230037064A1, published 2023, now pending, Piran Ravichandran Kidambi, Sokrates T. Pantelides, Andrew O'Hara, De-Liang Bao, Nicole Moehring

PRESENTATIONS

1. A barrierless on-surface metalation process for porphyrin-based molecules. (Oral) **China Nano Meeting**, 2017 August, Beijing, China
2. Large-scale formation of ordered one-third-hydrogenated graphene on Ru(0001). (Oral) **APS March Meeting**, 2018 March, Los Angeles, U.S.

3. Fabrication of millimeter-scale, single-crystal one-third-hydrogenated graphene with anisotropic electronic properties (Oral), **The 10th annual Recent Progress in Graphene and Two-dimensional Materials Research Conference**, 2018 October, Guilin, China
4. Direct visualization of hydrogen-transfer intermediate states by scanning tunneling microscopy (Oral), **APS March Meeting**, 2019 March, Boston, U. S.
5. Tunable, ferroelectricity-inducing, spin-spiral magnetic ordering in monolayer FeOCl. (Oral) **APS March Meeting**, 2021 March, online.
6. Atomically resolved phonons localized at defects in monolayer graphene. (Oral) **APS March Meeting**, 2022 March, Chicago.

Mentoring

2021 One Vanderbilt REU (Research Experience for Undergraduate) student, “Permeability and selectivity of silicon-passivated nanopores in graphene”

2022 One Vanderbilt REU student, “Theoretical investigations on biphenylene as an atom filter”

2022 One Vanderbilt undergraduate, “Theoretical calculations on hydrogen atoms transferring through monolayer borophene.”

2023 Two Vanderbilt undergraduates and one PhD.