



Andrew J. Mannix

Assistant Professor of Materials Science and Engineering

Bio

BIO

Andrew J. Mannix is an assistant professor of Materials Science and Engineering at Stanford University. He completed his B.S. in Materials Science and Engineering at the University of Illinois at Urbana-Champaign, and his Ph.D. in Materials Science and Engineering at Northwestern University as an NSF GRFP Fellow, where he worked on the growth and atomic-scale characterization of new 2D materials. Before moving to Stanford, Andy was a Kadanoff-Rice Postdoctoral Fellow in the James Franck Institute at the University of Chicago, where he developed new methods of atomically-thin nanomaterials growth, processing, and automated heterostructure assembly. His lab at Stanford focuses on the growth, assembly and atomic-scale characterization of 2D materials for new electronic and quantum information science applications.

ACADEMIC APPOINTMENTS

- Assistant Professor, Materials Science and Engineering
- Member, Bio-X

PROFESSIONAL EDUCATION

- Ph.D., Northwestern University , Materials Science and Engineering (2017)
- B.S., University of Illinois at Urbana-Champaign , Materials Science and Engineering (2012)

LINKS

- Research Group Website: <https://www.2d-matsci.com/>

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Atomically thin 2D materials incorporated into van der Waals heterostructures are a promising platform to deterministically engineer quantum materials with atomically resolved thickness and abrupt interfaces across macroscopic length scales while retaining excellent material properties. Because 2D materials exhibit a wide range of electronic characteristics with properties that often rival conventional electronic materials — e.g., metals, semiconductors, insulators, and superconductors — it is possible to combine them in virtually infinite variety to achieve diverse heterostructures. Furthermore, the van der Waals interface enables interlayer twist engineering to modify the interlayer symmetry, periodic potential (moiré superlattice), and hybridization, which has resulted in novel quantum states of matter. Many of these heterostructures, especially those involving specific interlayer twist angles, would be otherwise infeasible through direct growth.

The Mannix Group is developing a unique set of in-house capabilities to systematically elucidate the fundamental structure-property relationships underpinning the growth of 2D materials and their inclusion into van der Waals heterostructures. Greater understanding will allow us to provide a platform for engineering the properties of matter at the atomic scale and offer guidance for emerging applications in novel electronics and in quantum information science.

To accomplish this, we employ: precise growth techniques such as chemical vapor deposition and molecular beam epitaxy; automated van der Waals assembly; and atomically-resolved microscopy including cryo-STM/AFM.

Teaching

COURSES

2022-23

- Ethics and Broader Impacts in Materials Science: MATSCI 232 (Spr)
- Introduction to Materials Science, Energy Emphasis: ENGR 50E (Win)
- Structure and Symmetry: MATSCI 184 (Aut)
- Structure and Symmetry: MATSCI 214 (Aut)

2021-22

- Ethics and Broader Impacts in Materials Science: MATSCI 232 (Spr)
- Structure and Symmetry: MATSCI 184 (Aut)
- Structure and Symmetry: MATSCI 214 (Aut)

2020-21

- Introduction to Materials Science, Energy Emphasis: ENGR 50E (Sum)
- Structure and Bonding: MATSCI 214 (Aut)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Lauren Hoang, Emily Lindgren, Yanbing Zhu

Postdoctoral Faculty Sponsor

Zhepeng Zhang

Doctoral Dissertation Co-Advisor (AC)

Risa Hocking

Master's Program Advisor

Wei-Chun Hsu, Madhurima Mahajan, Sam Ye, Qingyang Zhu

Publications

PUBLICATIONS

- **Robotic four-dimensional pixel assembly of van der Waals solids.** *Nature nanotechnology*
Mannix, A. J., Ye, A., Sung, S. H., Ray, A., Mujid, F., Park, C., Lee, M., Kang, J., Shreiner, R., High, A. A., Muller, D. A., Hovden, R., Park, et al
1800
- **Borophene as a prototype for synthetic 2D materials development** *NATURE NANOTECHNOLOGY*
Mannix, A. J., Zhang, Z., Guisinger, N. P., Yakobson, B. I., Hersam, M. C.
2018; 13 (6): 444-450

- **Synthesis and chemistry of elemental 2D materials** *NATURE REVIEWS CHEMISTRY*
Mannix, A. J., Kiraly, B., Hersam, M. C., Guisinger, N. P.
2017; 1 (2)
- **Synthesis of borophenes: Anisotropic, two-dimensional boron polymorphs** *SCIENCE*
Mannix, A. J., Zhou, X., Kiraly, B., Wood, J. D., Alducin, D., Myers, B. D., Liu, X., Fisher, B. L., Santiago, U., Guest, J. R., Yacaman, M., Ponce, A., Oganov, et al
2015; 350 (6267): 1513-1516
- **Resist-Free Lithography for Monolayer Transition Metal Dichalcogenides.** *Nano letters*
Poddar, P. K., Zhong, Y., Mannix, A. J., Mujid, F., Yu, J., Liang, C., Kang, J., Lee, M., Xie, S., Park, J.
1800
- **Wafer-scale synthesis of monolayer two-dimensional porphyrin polymers for hybrid superlattices** *SCIENCE*
Zhong, Y., Cheng, B., Park, C., Ray, A., Brown, S., Mujid, F., Lee, J., Zhou, H., Suh, J., Lee, K., Mannix, A. J., Kang, K., Sibener, et al
2019; 366 (6471): 1379-+
- **Near-equilibrium growth from borophene edges on silver** *SCIENCE ADVANCES*
Zhang, Z., Mannix, A. J., Liu, X., Hu, Z., Guisinger, N. P., Hersam, M. C., Yakobson, B. I.
2019; 5 (9): eaax0246
- **Edge states in the honeycomb reconstruction of two-dimensional silicon nanosheets** *APPLIED PHYSICS LETTERS*
Mannix, A. J., Saari, T., Kiraly, B., Fisher, B. L., Hsu, C., Huang, Z., Chuang, F., Nieminen, J., Lin, H., Bansil, A., Hersam, M. C., Guisinger, N. P.
2019; 115 (2)
- **Amino Acid Immobilization of Copper Surface Diffusion on Cu(111)** *ADVANCED MATERIALS INTERFACES*
Guisinger, N. P., Mannix, A. J., Rankin, R. B., Kiraly, B., Phillips, J. A., Darling, S. B., Fisher, B. L., Hersam, M. C., Iski, E. V.
2019; 6 (7)
- **Borophene Synthesis on Au(111)** *ACS NANO*
Kiraly, B., Liu, X., Wang, L., Zhang, Z., Mannix, A. J., Fisher, B. L., Yakobson, B. I., Hersam, M. C., Guisinger, N. P.
2019; 13 (4): 3816-3822
- **Driving chemical interactions at graphene-germanium van der Waals interfaces via thermal annealing** *APPLIED PHYSICS LETTERS*
Kiraly, B., Mannix, A. J., Jacobberger, R. M., Fisher, B. L., Arnold, M. S., Hersam, M. C., Guisinger, N. P.
2018; 113 (21)
- **Resolving the Chemically Discrete Structure of Synthetic Borophene Polymorphs** *NANO LETTERS*
Campbell, G. P., Mannix, A. J., Emery, J. D., Lee, T., Guisinger, N. P., Hersam, M. C., Bedzyk, M. J.
2018; 18 (5): 2816-2821
- **Epitaxial graphene-encapsulated surface reconstruction of Ge(110)** *PHYSICAL REVIEW MATERIALS*
Campbell, G. P., Kiraly, B., Jacobberger, R. M., Mannix, A. J., Arnold, M. S., Hersam, M. C., Guisinger, N. P., Bedzyk, M. J.
2018; 2 (4)
- **Self-assembly of electronically abrupt borophene/organic lateral heterostructures** *SCIENCE ADVANCES*
Liu, X., Wei, Z., Balla, I., Mannix, A. J., Guisinger, N. P., Luijten, E., Hersam, M. C.
2017; 3 (2): e1602356
- **Substrate-Induced Nanoscale Undulations of Borophene on Silver** *NANO LETTERS*
Zhang, Z., Mannix, A. J., Hu, Z., Kiraly, B., Guisinger, N. P., Hersam, M. C., Yakobson, B. I.
2016; 16 (10): 6622-6627
- **Sub-5 nm, globally aligned graphene nanoribbons on Ge(001)** *APPLIED PHYSICS LETTERS*
Kiraly, B., Mannix, A. J., Jacobberger, R. M., Fisher, B. L., Arnold, M. S., Hersam, M. C., Guisinger, N. P.
2016; 108 (21)
- **Electronic and Mechanical Properties of Graphene-Germanium Interfaces Grown by Chemical Vapor Deposition** *NANO LETTERS*
Kiraly, B., Jacobberger, R. M., Mannix, A. J., Campbell, G. P., Bedzyk, M. J., Arnold, M. S., Hersam, M. C., Guisinger, N. P.
2015; 15 (11): 7414-7420

- **Graphene-Silicon Heterostructures at the Two-Dimensional Limit** *CHEMISTRY OF MATERIALS*
Kiraly, B., Mannix, A. J., Hersam, M. C., Guisinger, N. P.
2015; 27 (17): 6085-6090
- **Direct oriented growth of armchair graphene nanoribbons on germanium** *NATURE COMMUNICATIONS*
Jacobberger, R. M., Kiraly, B., Fortin-Deschenes, M., Levesque, P. L., McElhinny, K. M., Brady, G. J., Delgado, R., Roy, S., Mannix, A., Lagally, M. G., Evans, P. G., Desjardins, P., Martel, et al
2015; 6: 8006
- **Silicon Growth at the Two-Dimensional Limit on Ag(111)** *ACS NANO*
Mannix, A. J., Kiraly, B., Fisher, B. L., Hersam, M. C., Guisinger, N. P.
2014; 8 (7): 7538-7547
- **Solid-source growth and atomic-scale characterization of graphene on Ag(111)** *NATURE COMMUNICATIONS*
Kiraly, B., Iski, E. V., Mannix, A. J., Fisher, B. L., Hersam, M. C., Guisinger, N. P.
2013; 4