Itai Y. Stein

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EDUCATION

Massachusetts Institute of Technology — Cambridge, MA

Ph.D., Mechanical Engineering — 2016
National Defense Science & Engineering Graduate Fellow
Thesis Title: *Impact of Morphology and Confinement Effects on the Properties of Aligned Nanofiber Architectures*
Advisor: Brian L. Wardle

S.M., Mechanical Engineering — 2013
Thesis Title: *Synthesis and Characterization of Next-Generation Multifunctional Material Architectures: Aligned Carbon Nanotube Carbon Matrix Nanocomposites*
Advisor: Brian L. Wardle

Carnegie Mellon University — Pittsburgh, PA

B.S., Materials Science and Engineering — 2011
University Honors, with Honors in Engineering

PROFESSIONAL APPOINTMENTS

Massachusetts Institute of Technology — Cambridge, MA

Postdoctoral Associate, Department of Aeronautics and Astronautics — 2016 – Present

PUBLICATIONS

Refereed Journal Articles

* = corresponding author; ‡ = equal contribution

[J11] C. A. Amadei‡, I. Y. Stein‡, G. J. Silverberg, B. L. Wardle, and C. D. Vecitis*. Fabrication and morphology tuning of graphene oxide nanoscrolls. *Nanoscale* **8**, 6783 (2016).

In the press: **MIT News**

[J10] I. Y. Stein*, and B. L. Wardle. Mechanics of aligned carbon nanotube polymer matrix nanocomposites simulated via stochastic three-dimensional morphology. *Nanotechnology* **27**, 035701 (2016).

In the press: **nanotechweb.org**

[J9] I. Y. Stein*, and B. L. Wardle. Packing morphology of wavy nanofiber arrays. *Physical Chemistry Chemical Physics* **18**, 694 (2016).

[J8] I. Y. Stein, D. J. Lewis, and B. L. Wardle*. Aligned carbon nanotube array stiffness from stochastic three-dimensional morphology. *Nanoscale* **7**, 19426 (2015).

[J7] J. Lee‡, I. Y. Stein‡, S. S. Kessler, and B. L. Wardle*. Aligned Carbon Nanotube Film Enables Thermally Induced State Transformations in Layered Polymeric Materials. *ACS Applied Materials & Interfaces* **7**, 8900 (2015).

In the press: **MIT News**, **physicsworld**, **Composites Today**, **MIT Technology Review**

[J6] J. Lee‡, I. Y. Stein‡, M. E. Devoe, D. J. Lewis, N. Lachman, S. S. Kessler, S. T. Buschhorn, and B. L. Wardle*. Impact of carbon nanotube length on electron transport in aligned carbon nanotube networks. *Applied Physics Letters* **106**, 053110 (2015). Open Access

[J5] I. Y. Stein, N. Lachman, M. E. Devoe, and B. L. Wardle*. Exohedral Physisorption of Ambient Moisture Scales Non-monotonically with Fiber Proximity in Aligned Carbon Nanotube Arrays. *ACS Nano* **8**, 4591 (2014). Open Access

[J4] I. Y. Stein*, and B. L. Wardle. Morphology and processing of aligned carbon nanotube carbon matrix nanocomposites. *Carbon* **68**, 807 (2014).

[J3] H. Cebeci‡, I. Y. Stein‡, and B. L. Wardle*. Effect of nanofiber proximity on the mechanical behavior of high volume fraction aligned carbon nanotube arrays. *Applied Physics Letters* **104**, 023117 (2014). Open Access

[J2] D. Handlin‡, I. Y. Stein‡, R. Guzman de Villoria, H. Cebeci, E. M. Parsons, S. Socrate, S. Scotti, and B. L. Wardle*. Three-dimensional elastic constitutive relations of aligned carbon nanotube architectures. *Journal of Applied Physics* **114**, 224310 (2013). Open Access

[J1] I. Y. Stein*, and B. L. Wardle. Coordination number model to quantify packing morphology of aligned nanowire arrays. *Physical Chemistry Chemical Physics* **15**, 4033 (2013). Open Access

Conference Proceedings

[P3] I. Y. Stein, and B. L. Wardle. Influence of Waviness on the Elastic Properties of Aligned Carbon Nanotube Polymer Matrix Nanocomposites. *Proceedings of the 57th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials (SDM) Conference* (AIAA, 2016), paper 2016-0151.

[P2] J. Lee, I. Stein, S. Kessler, and B. Wardle. Out-of-Oven Curing of Composite Laminates via Resistive Microheaters Comprised of Aligned Carbon Nanotube Networks. *Proceedings of the 20th International Conference on Composite Materials* (ICCM, 2015), paper 150701-3205.

[P1] I. Y. Stein, H. M. Vincent, S. A. Steiner, E. Colombini, and B. L. Wardle. Processing and Mechanical Property Characterization of Aligned Carbon Nanotube Carbon Matrix Nanocomposites. *Proceedings of the 54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials (SDM) Conference* (AIAA, 2013), paper 2013-1583.

Manuscripts in Preparation/Submission

8. I. Y. Stein, A. J. Constable, N. Morales-Medina, C. V. Sackier, M. E. Devoe, H. M. Vincent, and B. L. Wardle*. Structure-mechanical property relations of non-graphitizing pyrolytic carbon synthesized at low temperatures. Submitted to *Nature Communications*.

7. H. K. Mutha, Y. Lu, I. Y. Stein, H. J. Cho, M. E. Suss. T. Laoui, C. V. Thompson, B. L. Wardle*, and E. N. Wang*. Porosimetry and packing morphology of vertically-aligned carbon nanotube arrays *via* impedance spectroscopy. Submitted to *Applied Physics Letters*.
6. N. Lachman‡, I. Y. Stein‡, A. Ugur‡, K. K. Gleason, and B. L. Wardle*. Nano-necklace of Polymer Beads on Aligned Carbon Nanotube Scaffolds. To be submitted for publication.
5. N. Lachman‡, B. Natarajan‡, I. Y. Stein‡, D. Jacobs, R. Sharma, J. A. Liddle, and B. L. Wardle*. Structure-Property Relations of Aligned Carbon Nanotube Polymer Composites via Quantitative 3-D Nanoscale Characterization. To be submitted for publication.
4. I. Y. Stein*, A. L. Kaiser, A. J. Constable, and B. L. Wardle*. Carbon nanotube confinement leads to meso-scale evolution of pyrolytic carbon matrix while retaining original atomic structure in aligned carbon nanotube carbon matrix nanocomposites.
3. I. Y. Stein, C. V. Sackier, S. A. Steiner, and B. L. Wardle*. Aligned Carbon Nanotube Ceramic Matrix Nanocomposites for Next Generation Multifunctional Architectures.
2. D. J. Lewis‡, I. Y. Stein‡, and B. L. Wardle*. Static and Fatigue Short Beam Shear Strength Investigation of Aligned Carbon Nanotube-Reinforced Prepreg Composite Interfaces.
1. H. Cebeci, I. Y. Stein, Y. Ateşcan, H. S. Türkmen, and B. L. Wardle*. Effective Stiffness of Wavy Aligned Carbon Nanotubes for Modeling of Controlled Morphology Polymer Nanocomposites.

AWARDS AND DISTINCTIONS

Department of Defense
National Defense Science & Engineering Graduate Fellowship 2013

National Science Foundation
NSF Graduate Research Fellowship – Honorable Mention 2011

ASM International
Young Members Night Poster Competition – 2nd Place 2011

Carnegie Mellon University
Dean's List (College of Engineering) 2009 – 2011
Small Undergraduate Research Grant (SURG) 2010
Intel IFYRE and SRC-URO Poster Competition – 2nd Place 2010
CMU Mobile Robot (MOBOT) Competition – 2nd Place 2010
Intel First Year Research Experience (IFYRE) Fellowship 2009

INVITED TALKS

[I4] "Impact of Morphology and Confinement Effects on the Properties of Aligned Carbon Nanotube Architectures," Harvard University, Cambridge, MA, August 5 (2016).

[I3] "Impact of Morphology and Confinement Effects on the Properties of Aligned Carbon Nanotube Architectures," National Institute of Standards and Technology, Gaithersburg, MD, May 13 (2016).

[I2] "Impact of Morphology and Confinement Effects on the Properties of Aligned Carbon Nanotube Architectures," University of Illinois at Urbana−Champaign, Urbana, IL, July 3 (2015).

[I1] "Aligned Carbon Nanotube Carbon Matrix Nanocomposites for Next-Generation Material Architectures," Lockheed Martin Advanced Technology Center, Palo Alto, CA, April 8 (2015).

CONFERENCE ACTIVITY

† = presenting author

[A10] B. Natarajan†, N. Lachman, I. Y. Stein, R. Sharma, B. L. Wardle, and J. A. Liddle. Structure-Property Relations of Aligned Carbon Nanotube: Polymer Composites via Quantitative 3D Electron Tomography. *2016 MRS Spring Meeting & Exhibit*, Pheonix, AZ, March 28 – April 1 (2016).

[A9] I. Y. Stein†, and B. L. Wardle. Mechanical properties of aligned carbon nanotube architectures: origin from 3D morphology. *APS March Meeting 2016*, Baltimore, MD, March 14 – 18 (2016).

[A8] I. Y. Stein†, and B. L. Wardle. Influence of Waviness on the Elastic Properties of Aligned Carbon Nanotube Polymer Matrix Nanocomposites. *57th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials (SDM) Conference*, AIAA SciTech 2016, San Diego, CA, January 4 – 8 (2016).

[A7] I. Y. Stein†, B. Natarajan, J. A. Liddle, and B. L. Wardle. Modeling the Morphology of Aligned Carbon Nanotube Arrays in Three Dimensions. *2015 MRS Fall Meeting & Exhibit*, Boston, MA, November 29 – December 4 (2015).

[A6] J. Lee†, I. Stein, S. Kessler, and B. Wardle. Out-of-Oven Curing of Composite Laminates via Resistive Microheaters Comprised of Aligned Carbon Nanotube Networks. *20th International Conference on Composite Materials*, Copenhagen, Denmark, July 19 – 24 (2015).

[A5] I. Y. Stein†, and B. L. Wardle. How Morphology and Proximity Effects Impact the Processing and Performance of Aligned Carbon Nanotube Carbon Matrix Nanocomposites. *ASME 2015 Applied Mechanics and Materials Conference (McMAT2015)*, Seattle, WA, June 29 – July 1 (2015).

[A4] I. Y. Stein†, and B. L. Wardle. Influence of Confinement Effects on the Morphology and Mechanical Behavior of Aligned Carbon Nanotube Systems. *2015 MRS Spring Meeting & Exhibit*, San Francisco, CA, April 6 – 10 (2015).

[A3] I. Y. Stein†, M. E. Devoe, N. Morales, H. M. Vincent, and B. L. Wardle. Impact of Proximity Effects on Structure-Property Relations of Aligned Carbon Nanotube Carbon Matrix Nanocomposites. *2014 MRS Fall Meeting & Exhibit*, Boston, MA, November 30 – December 5 (2014).

[A2] I. Y. Stein†, H. M. Vincent, S. A. Steiner, E. Colombini, and B. L. Wardle. Processing and Mechanical Property Characterization of Aligned Carbon Nanotube Carbon Matrix Nanocomposites. *54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials (SDM) Conference*, Boston, MA, April 8 – 11 (2013).

[A1] I. Y. Stein†, and B. L. Wardle. Coordination Number Model to Define Average Packing Morphology of Aligned Nanofiber Arrays. *2012 MRS Fall Meeting & Exhibit*, Boston, MA, November 25 – 30 (2012).

TEACHING EXPERIENCE

Hands-On Aerospace 2016 (January)
Guest lecture: "Aerospace Materials & Structures"

RESEARCH EXPERIENCE

Massachusetts Institute of Technology, Cambridge MA

National Defense Science & Engineering Graduate Fellow 2013 – 2016

Studying the underlying physics and chemistry that govern the behavior of nanofibers, nanowires, and nanotubes organized into aligned arrays.

Research Assistant 2011 – 2013

Synthesized and characterized the structure and mechanical properties of aligned carbon nanotube carbon matrix nanocomposites.

RESEARCH MENTORING AND SUPERVISION

Graduate

[G8] **Hayden K. Cornwell** 2016
Currently a S.M. candidate in Aeronautics and Astronautics, Massachusetts Institute of Technology. Advised on S.M. research.

[G7] **Xinchen Ni** 2016
Currently a Ph.D. candidate in Mechanical Engineering, Massachusetts Institute of Technology. Advised on Ph.D. research (including Ph.D. proposal).

[G6] **Dale L. Lidston** 2016
Currently a S.M. candidate in Aeronautics and Astronautics, Massachusetts Institute of Technology. Advised on S.M. research.

[G5] **Diana J. Lewis** 2015
Currently a Ph.D. candidate in Aeronautics and Astronautics, Massachusetts Institute of Technology. Advised on S.M. thesis. *Interlaminar Shear Strength Investigation of Aligned Carbon Nanotube-Reinforced Prepreg Composite Interfaces*.

[G4] **Zeng (Wendy) Fan** 2014
Visiting Ph.D. student from the Department of Mechanical Engineering, National University of Singapore. Hosted at MIT for 3 months. *Advanced Fabrication and Multifunctional Properties of Morphology-controlled Graphene Aerogels and Their Composites*.

[G3] **Jenyoon Lee** 2013 – 2015
Currently a Ph.D. candidate in Mechanical Engineering, Massachusetts Institute of Technology. Supervised and advised on Ph.D. research (including Ph.D. proposal) and S.M. thesis: *In Situ Curing of Polymeric Composites via Resistive Heaters Comprised of Aligned Carbon Nanotube Networks*.

[G2] **Daniel A. Handlin** 2013
S.M. student in Aeronautics and Astronautics, Massachusetts Institute of Technology. Advised on S.M. thesis: *Three-Dimensional Constitutive Relations of Aligned Carbon Nanotube Polymer Nanocomposites*.

[G1] **Jin Hyeok Cha** 2012 – 2013
Visiting Ph.D. student from the Department of Mechanical Engineering, The University of Tokyo. Hosted at MIT for 6 months. *Enhancement of Physical Properties of Aligned CNTs/PDMS Nanocomposite*.

Undergraduate

[U10] **Ashley L. Kaiser** 2016
Summer scholar in the Materials Processing Center, Massachusetts Institute of Technology. *Meso-scale Evolution of Pyrolytic Carbon Confined by Aligned Carbon Nanotubes*.

[U9] **Alexander J. Constable** 2015
Summer scholar in the Materials Processing Center, Massachusetts Institute of Technology. *Nanoscale Proximity Effects of Aligned Carbon Nanotubes on Pyrolytic Carbon Matrix Growth in Nanocomposites*.

[U8] **Chlöe V. Sackier** 2015 – Present
Undergraduate student in Aeronautics and Astronautics, Massachusetts Institute of Technology. *Aligned Carbon Nanotube Carbon Matrix Nanocomposites: Synthesis and Characterization*.

[U7] **Roget Mo** 2015
Undergraduate student in Mechanical Engineering, Massachusetts Institute of Technology. *Aligned Carbon Nanotube Carbon Matrix Nanocomposites: Synthesis and Characterization*.

[U6] **Naomi Morales-Medina** 2014
Summer scholar in the Materials Processing Center, Massachusetts Institute of Technology. *Quantification of Nanocrystallite Defects in Aligned Carbon Nanotube Carbon Matrix Nanocompsites*.

[U5] **Mackenzie E. Devoe** 2012 – 2015
Undergraduate student in Materials Science and Engineering, Massachusetts Institute of Technology. Supervised and advised on S.B. thesis: *Structure-property Relations of Nanostructured Carbon Systems as a Function of Processing*.

[U4] **Juan J. Hernandez** 2012
Undergraduate student in Materials Science and Engineering, Massachusetts Institute of Technology. *Characterization of Vertically Aligned Carbon Nanotube Composites by X-Ray Scattering Techniques*.

[U3] **Hanna M. Vincent** 2012 – 2014
Undergraduate student in Materials Science and Engineering, Massachusetts Institute of Technology. *Surface Morphology and Structure Characterization of Aligned Carbon Nanotube Ceramic Matrix Nano Composites (A-CMNCs)*.

[U2] **Peter Florin** 2012
Undergraduate student in Aeronautics and Astronautics, Massachusetts Institute of Technology. *Design and Fabrication of Aligned-Carbon Nanotube Nanocomposite Synthesis Apparatuses*.

[U1] **Henna L. Jethani** 2012
Undergraduate student in Aeronautics and Astronautics, Massachusetts Institute of Technology. *Carbon Nanotube Based Ceramic Nano-materials for High Temperature Aerospace Applications*.

JOURNAL REFEREE

Nanotechnology, *Journal of Materials Science*, *Carbon*, *Journal of Composite Materials*, *European Journal of Mechanics - A/Solids*.

EXTRACURRICULAR UNIVERSITY SERVICE

Massachusetts Institute of Technology
Ashdown House (NW35) Technology Committee 2012 – 2015

STEM OUTREACH

[O9] "Introduction to Stoichometry," Honors Chemistry, Dr. Tae Cho, Sharon High School, Sharon, MA, January 2012.

[O8] "Introduction to Thermodynamics," Honors Chemistry, Dr. Tae Cho, Sharon High School, Sharon, MA, May 2011.

[O7] "Thermodynamics of Melting Ice Using Salt," AP Chemistry, Dr. Shawn Kenner, Sharon High School, Sharon, MA, December 2010.

[O6] "Introduction to Properties and Applications of Polymeric Materials," AP Chemistry, Dr. Shawn Kenner, Sharon High School, Sharon, MA, December 2009.

[O5] "Carbon Nanotubes: An Introduction," AP Chemistry, Dr. Shawn Kenner, Sharon High School, Sharon, MA, May 2009.

[O4] "Reactions Prediction Review," AP Chemistry, Dr. Shawn Kenner, Sharon High School, Sharon, MA, January 2009.

[O3] "Introduction to Materials Science and Engineering," AP Chemistry, Dr. Shawn Kenner, Sharon High School, Sharon, MA, May 2008.

[O2] "Introduction to Chemical Reactions," Honors Chemistry, Dr. Shawn Kenner, Sharon High School, Sharon, MA, January 2008.

[O1] "Intermolecular Forces," Honors Chemistry, Dr. Shawn Kenner, Sharon High School, Sharon, MA, May 2007.

PROFESSIONAL MEMBERSHIPS

American Physical Society (APS)	2015 – Present
American Society of Mechanical Engineers (ASME)	2015 – Present
American Institute of Aeronautics and Astronautics (AIAA)	2013 – Present
Materials Research Society (MRS)	2012 – Present

REFERENCES

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Cambridge, MA 02139, USA
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Carnegie Mellon University
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Additional references available upon request