Riley Hanus

Northwestern University
Materials Science and Engineering
2200 Campus Drive - Cook 3050
Evanston, IL, USA, 60045

rhanus@u.northwestern.edu
www.rileyhanus.com
Skype: riley.hanus
Phone: email for number

Education

Northwestern University
Ph.D., Materials Science and Engineering, 2014 – Fall 2019 (expected)
Fields: Solid-state physics/chemistry, Heat transport, Thermoelectrics
GPA: 3.83/4.0

Thesis "Heat conduction in defective solids: phonon scattering and beyond"

The flow of heat through solids is a topic of technological importance for micro/nanoelectronics and energy materials. This thesis utilized a combined experimental and theoretical approach to establish materials design principles in defective crystals. Particular focus was given to the influence of interfaces [4, 14], dislocations [1], point defects [6] on thermal transport. Additionally, the influence of chemical bonding and electronic doping on the electronic band structure of skutterudite thermoelectrics was established [10].

Iowa State University
B.S., Materials Engineering, 2013
Minor, Music Technology, 2013
GPA: 3.63/4.0

Experience

Bemis North America
Product Development Engineer, Jan. 2014 – Aug. 2014

Primary technical contact for Bemis forming film products. Built Bemis' innovation pipeline with new technological developments. Conducted independent research projects to differentiate Bemis technology from competitors.

Ames Laboratory: US Departement of Energy
Undergraduate Research Assistant, 2012 – 2013

Worked in Dr. Schmidt-Rohr's research group for Dr. Evgenii Levin developing experimental methods for improving the performance of GeTe- and Mg_2Si-based thermoelectric materials [17, 20, 21].

Iowa State University: Materials Engineering
Undergraduate Research Assistant, 2010 – 2012

Worked in Dr. Michael Kessler's polymer composite research group, including two Science Undergraduate Laboratory Internships (SULI). Developed a method for toughening a high performance thermosetting resin [22]. Analyzed the environmental degradation of bio-renewable polymers [19].

Teaching

Materials Science and Engineering, Northwestern University
Teaching Assistant, Introductory Physics of Materials (MSE 351-1, 2015)
Taught one recitation class a week. Guest lectured. Created and taught the computational lab section (2015, 2016, 2018). Graded homework, lab reports, and exams. Developed material for the implementation of an online course.

Materials Engineering, Iowa State Engineering
Grader/Course Assistant, Intoduction to Polymers (Mat E 351, 2012)
Guest lectured. Held review sessions. Graded homework and lab reports.

Awards & Fellowships

Science Graduate Research Award (2018)
National award enabling outstanding U.S. graduate students to pursue graduate research at a DOE laboratory (this case: Oak Ridge National Lab).

Weertman Fellowship (2018)
Achievement-based award to recognize one Ph.D. candidate in Northwestern Materials Science and Engineering for outstanding scholarly achievements and promise.

McCormick Global Initiatives: Student Ambassador Award (2016)
Award funding a portion of my trip to Arusha Tanzania for the 2016 JUAMI Outreach program.

National Defense Science & Engineering Graduate Fellowship (2015)
Honorable Mention

National Science Foundation Graduate Research Fellowship (2015)
Alternate Selectee

Dean's List: ISU College of Engineering
Fall 2009, Fall 2010, Fall 2011, Fall 2012, and Spring 2013

Iowa State Academic Recognition Award (2009-2013)
Scholarship recognizing academic achievement.

Delta Tau Delta National Fraternity awards:
Excellence in Recruitment Programming (Feb. 2012)
Exceeding Recruitment Goals (Feb. 2012)
Hugh Shields Award for Chapter Excellence (Feb. 2012)

ISU Materials Science Undergraduate Poster Competition:
1st place (2012), 3rd place (2013)

Leadership

Materials Science and Engineering, Northwestern University
Vice President for Materials Science Student Association (2015 – 2016)

Organized and executed prospective student visit weekends. Conducted Materials Science social and professional networking events. Organized outreach programs.

Delta Tau Delta Fraturnity, ISU chapter (Gamma Pi)
Vice President of Recruitment (2012)

Operated on an award winning Executive Committee for a 90+ member chapter and managed a three-member recruitment team (see Awards). Exceeded our recruitment goal by 36% and maintained a 97% retention rate while staying under budget.

Outreach

Joint Undertaking for an African Materials Institute (JUAMI)
Outreach workshop hosted by the Nelson Mandela African Institution of Science and Technology in Arusha, Tanzania (www.juami.org). Teaching assistant for the thermoelectrics sub-section. Designed, built, and lead an hands on lab activity for native African scientists and other JUAMI participants. Read about the experience at juamiafrica.blogspot.com.

Languages

Coding and Software
Python (advanced; data analytics, user interface development), Mathematica (advanced), General Structure Analysis System (GSAS-II, advanced; GSASscriptable.py), MATLAB (intermediate), HTML/CSS/JS (intermediate), almaBTE (intermediate), VASP (basic), LaTeX

Skills

Lab Expertise
Laser Flash Analysis (experience running, servicing, and repairing Netzsch LFA 457); Ultrasound characterization (Pulse-Echo and Resonant Ultrasound Spectroscopy); X-Ray diffraction (phase analysis, structure refinement, Laue, microstructural analysis, synchrotron experience, 11-BM APS); Synthesis: quartz ampule chemistry, single crystal growth and characterization; Scanning electron microscopy (SEM); Electrical Conductivity (Van der Pauw, 4-point probe); Seebeck Coefficient; Differential scanning calorimetry (DSC); Dynamic mechanical analysis (DMA); Fourier transform infrared spectroscopy (FT-IR); Mechanical testing (Instron); Rheology testing; Thermogravimetric analysis (TGA); Thermomechanical analysis (TMA)

Peer Review

APL Materials (2), Advanced Science (1)

Publications

1. **Hanus, R.,** Agne, M. T., Rettie, A. J. E., Chen, Z., Tan, G., Chung, D. Y., Kanatzidis, M. G., Pei, Y., Voorhees, P. W., Snyder, G. J., Lattice Softening Significantly Reduces Thermal Conductivity and Leads to High Thermoelectric Efficiency. *Advanced Materials* **1900108,** 1900108 (Apr. 2019).
2. Rangnekar, S., **Hanus, R.,** Julia and Hans Weertman: A legacy of scholarship, mentorship, and lives well-lived. *MRS Bulletin* **44,** 221–222 (Mar. 2019).
3. Agne, M. T., **Hanus, R.,** Snyder, G. J., Minimum thermal conductivity in the context of diffuson-mediated thermal transport. *Energy and Environmental Science* **11,** 609–616 (2018).
4. **Hanus, R.,** Garg, A., Snyder, G. J., Phonon diffraction and dimensionality crossover in phonon-interface scattering. *Communications Physics* **1,** 78 (Dec. 2018).
5. Pan, Y., Aydemir, U., Grovogui, J. A., Witting, I. T., **Hanus, R.,** Xu, Y., Wu, J., Wu, C.-F., Sun, F.-H., Zhuang, H.-L., Dong, J.-F., Li, J.-F., Dravid, V. P., Snyder, G. J., Melt-Centrifuged $(Bi,Sb)_2Te_3$: Engineering Microstructure toward High Thermoelectric Efficiency. *Advanced Materials* **30,** 1802016 (Aug. 2018).
6. Tan, G., Hao, S., **Hanus, R. C.,** Zhang, X., Anand, S., Bailey, T. P., Rettie, A. J. E., Su, X., Uher, C., Dravid, V. P., Snyder, G. J., Wolverton, C., Kanatzidis, M. G., High Thermoelectric Performance in SnTe–$AgSbTe_2$ Alloys from Lattice Softening, Giant Phonon–Vacancy Scattering, and Valence Band Convergence. *ACS Energy Letters* **3,** 705–712 (Mar. 2018).
7. Xu, D., **Hanus, R.,** Xiao, Y., Wang, S., Snyder, G., Hao, Q., Thermal boundary resistance correlated with strain energy in individual Si film-wafer twist boundaries. *Materials Today Physics* **6,** 53–59 (Aug. 2018).
8. Chen, Z., Ge, B., Li, W., Lin, S., Shen, J., Chang, Y., **Hanus, R.,** Snyder, G. J., Pei, Y., Vacancy-induced dislocations within grains for high-performance PbSe thermoelectrics. *Nature Communications* **8,** 13828 (Jan. 2017).
9. Chen, Z., Jian, Z., Li, W., Chang, Y., Ge, B., **Hanus, R.,** Yang, J., Chen, Y., Huang, M., Snyder, G. J., Pei, Y., Lattice Dislocations Enhancing Thermoelectric PbTe in Addition to Band Convergence. *Advanced Materials* **29,** 1606768 (Jan. 2017).
10. **Hanus, R.,** Guo, X., Tang, Y., Li, G., Snyder, G. J., Zeier, W. G., A Chemical Understanding of the Band Convergence in Thermoelectric $CoSb_3$ Skutterudites: Influence of Electron Population, Local Thermal Expansion, and Bonding Interactions. *Chemistry of Materials* **29,** 1156–1164 (Feb. 2017).
11. Kang, S. D., Pöhls, J.-H., Aydemir, U., Qiu, P., Stoumpos, C. C., **Hanus, R.,** White, M. A., Shi, X., Chen, L., Kanatzidis, M. G., Snyder, G. J., Enhanced stability and thermoelectric figure-of-merit in copper selenide by lithium doping. *Materials Today Physics* **1,** 7–13 (2017).
12. Nunna, R., Qiu, P., Yin, M., Chen, H., **Hanus, R.,** Song, Q., Zhang, T., Chou, M. Y., Agne, M. T., He, J., Snyder, G. J., Shi, X., Chen, L., Ultrahigh thermoelectric performance in Cu_2Se-based hybrid materials with highly dispersed molecular CNTs. *Energy and Environmental Science* **10,** 1928–1935 (2017).

13. Zhao, K., Blichfeld, A. B., Chen, H., Song, Q., Zhang, T., Zhu, C., Ren, D., **Hanus, R.,** Qiu, P., Iversen, B. B., Xu, F., Snyder, G. J., Shi, X., Chen, L., Enhanced Thermoelectric Performance through Tuning Bonding Energy in $Cu_2Se_{1-x}S_x$ Liquid-like Materials. *Chemistry of Materials* **29,** 6367–6377 (Aug. 2017).

14. Zong*, P.-a., **Hanus*, R.,** Dylla, M., Tang, Y., Liao, J., Zhang, Q., Snyder, G. J., Chen, L., Skutterudite with graphene-modified grain-boundary complexion enhances zT enabling high-efficiency thermoelectric device. *Energy Environ. Sci.* **10.** *contibuted equally, 183–191 (2017).

15. Kim, H.-S., Kang, S. D., Tang, Y., **Hanus, R.,** Jeffrey Snyder, G., Dislocation strain as the mechanism of phonon scattering at grain boundaries. *Mater. Horiz.* **3,** 234–240 (2016).

16. Li, G., An, Q., Goddard, W. A., **Hanus, R.,** Zhai, P., Zhang, Q., Snyder, G. J., Atomistic explanation of brittle failure of thermoelectric skutterudite $CoSb_3$. *Acta Materialia* **103,** 775–780 (Jan. 2016).

17. Levin, E. M., **Hanus, R.,** Cui, J., Xing, Q., Riedemann, T., Lograsso, T. A., Schmidt-Rohr, K., Phase analysis and determination of local charge carrier concentration in eutectic Mg_2Si-Si alloys. *Materials Chemistry and Physics* **158,** 1–9 (2015).

18. Tang, Y., **Hanus, R.,** Chen, S.-w., Snyder, G. J., Solubility design leading to high figure of merit in low-cost Ce-$CoSb_3$ skutterudites. *Nature Communications* **6,** 7584 (July 2015).

19. Cui, H., **Hanus, R.,** Kessler, M. R., Degradation of ROMP-based bio-renewable polymers by UV radiation. *Polymer Degradation and Stability* **98,** 2357–2365 (2013).

20. Levin, E. M., Besser, M. F., **Hanus, R.,** Electronic and thermal transport in GeTe: A versatile base for thermoelectric materials. *Journal of Applied Physics* **114,** 083713 (Aug. 2013).

21. Levin, E. M., **Hanus, R.,** Hanson, M., Straszheim, W. E., Schmidt-Rohr, K., Thermoelectric properties of $Ag_2Sb_2Ge_{46-x}Dy_xTe_50$ alloys with high power factor. *physica status solidi (a)* **210,** 2628–2637 (Dec. 2013).

22. Sheng, X., **Hanus, R.,** Bauer, A., Kessler, M. R., Effect of PEGDE addition on rheological and mechanical properties of bisphenol E cyanate ester. *Journal of Applied Polymer Science* **130,** 463–469 (Oct. 2013).

Presentations

Invited:

- R. Hanus, G. J. Snyder. "Engineering thermal conductivity through microstructure". SPIE-MRSEC student seminar. Evanston, IL, USA. October 2018.

Conferences presentations:

- American Physical Society, Phoenix, Arizona, USA. March 2019. (30 min. invited talk for G. J. Snyder. 2 posters. Nominee for Best Poster Award)
- Materials Research Society (talk, poster). Boston, MA, USA. November 2018.
- International Conference of Thermoelectrics (talk). Caen, France. July 2018.

- American Physical Society (talk). Los Angeles, CA, USA. March 2018.
- Centre Européen de Calcul Atomique et Moléculaire (CECAM, talk). Paris, France. January 2018.
- Materials Research Society (2 talks). Boston, MA, USA. November 2017
- International Conference of Thermoelectrics (talk). Pasadina, CA, USA. July 2017.
- Electronic Materials Conference (talk). West Bend, IN, USA. June 2017.

References

Prof. G. Jeff Snyder
Materials Science, Northwestern University
jeff.snyder@northwestern.edu
+1 ()

Prof. Anupam Garg
Physics and Astronomy, Northwestern University
agarg@northwestern.edu
+1 (847) 491-3229

Dr. Raphael Hermann
Research Staff, Oak Ridge National Lab
hermannrp@ornl.gov
+1 (865) 576-4264

Prof. Mercouri Kanatzidis
Chemistry, Northwestern University
m-kanatzidis@northwestern.edu
+1 (847) 467-1541