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Resume - Cronin B. Vining

RESUME

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Born: August 22, 1957, Baltimore, Maryland USA

Attachment	Size
20090908-Vining-Resume-Full.pdf [3]	260.56 KB

Professional Experience

Professional Positions

1995-present President and founder, ZT Services

Information and consulting services to the energy conversion industry. Clients include Global 500 companies (Honda, Whirlpool), venture capitalists (Carl Berg, Dawson Ventures, Kleiner Perkins Caufield and Byers), thermoelectric manufacturing firms (Marlow, Melcor, Tellurex), federal agencies (Defense Advanced Research Projects Agency, Ames Laboratory USDoE, NASA/Glenn, NASA/JPL, NASA/HQ), and a variety of other clients (BSST, Tecumseh). ZT Services also maintains an extensive sponsor-supported web site on thermoelectrics (http://www.zts.com/ [2]) and provides web and internet services for the International Thermoelectric Society (http://www.its.org/ [4]), and a number of commercial clients.

1999-2003 Affiliate Professor of Physics, **Auburn University**, Auburn, Alabama

Collaborations with Prof. Peter Barnes's group on thermionic and thermoelectric

projects, resulting in several papers (written primarily by graduate students). Served on advisory committees for one Masters and two Ph.D. students.

1995 Guest Lecturer, Various Universities, Companies and National Laboratories in Japan (January).

1994-2004 Research Advisor, **Ames Laboratory USDoE**, Ames, Iowa.

Theoretical and experimental development of new thermoelectric materials. Emphasis on novel materials systems such as heavy fermions and metals, not traditionally associated with high thermoelectric performance.

1994 Consultant to **Dawson Ventures, Inc.**, San Jose, California

Evaluation of the technical and business potential of novel, high-risk/high-payoff energy conversion technologies.

1990-1991 Consultant to Marlow Industries, Dallas, Texas

Concepts, approaches and program plans for the development of advanced thermoelectric cooling materials capable of achieving cryogenic temperatures with efficiencies comparable to dynamic cooling technologies.

1987-1994 Member of Technical Staff

Jet Propulsion Laboratory/California Institute of Technology (Caltech), Pasadena, California, Thermal Power Conversion Group

Theoretical and experimental development of thermoelectric materials for advanced space power applications, with special emphasis on theoretical aspects of thermoelectric energy conversion and development of advanced thermoelectric materials. Task Manager for 4-5 tasks related to silicon-germanium, boron carbide and rare-earth chalcogenide thermoelectric materials, ($500K/year) 1988-89. Task Manager for advanced thermoelectric materials development, with emphasis on transition-metal silicides, ($200K-$250K/year) 1990-93. Task Manager for a JPL Technology Affiliates Program sponsored by Marlow Industries to transfer JPL developed thermoelectric technology based on skutterudite thermoelectric materials to Marlow Industries, ($350K/year) 1993-94. Proposal Manager for a three year program on the basic physics and chemistry of skutterudite thermoelectric materials sponsored by the Office of Naval Research, awarded in 1994 ($250K/year).

1984-1987 Senior Physicist

General Electric Company, Valley Forge Space Center, Thermoelectric Technology Group, Philadelphia, Pennsylvania.

Transport properties of semiconductors for high temperature thermal to electrical energy conversion applications.

Design and implementation of a complete high temperature thermoelectric materials

preparation and characterization facility suitable for research and development of state-of-the-art thermoelectric materials to be used in space nuclear power generation systems. This facility included induction and resistance melting, vacuum casting, pressure sintering, inert atmosphere handling capabilities as well as thermal diffusivity, thermal conductivity, electrical resistivity, Seebeck coefficient, Hall Effect, Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA), Thermogravimetric Analysis (TGA) and X-ray diffraction measurement capabilities, most of which could be performed from 300 to 1300 K. $750,000 value.

Program manager for internal General Electric R&D programs on thermoelectric materials (1984-$100,000; 1985-$160,000; 1986-$40,000). Program manager for NASA-JPL rare-earth chalcogenide development programs at General Electric (1984-1985-$130,000). Program manager for subcontract to Thermo Electron Corporation on SiGe/GaP alloy development (1986-$100,000). Project leader and principle investigator for DOE sponsored Improved Thermoelectric Materials Development program, $2,700,000 over 3 years.

Responsible for the daily direction of one Ph.D., two engineers and three technicians.

Education

Education

1983: Postdoctoral Fellow, Ames Laboratory-US Department of Energy, Ames, Iowa.

Acting group leader for a group of five graduate students and one technician.

1983: Ph.D. (Solid State Physics), Iowa State University, Ames, Iowa.

"Superconductivity and Long Range Magnetic Order in Ternary Rare-Earth Iron Silicides." Major professor: Dr. R. N. Shelton

1980-1983: Research Assistant, Ames Laboratory-US Department of Energy, Ames, Iowa.

Superconductivity and magnetism in novel materials. Preparation of novel superconducting, semiconducting and magnetically ordered materials including ternary rare-earth borides and silicides. X-ray diffraction and metallographic characterization. Superconducting and magnetic transition temperature determinations using magnetic susceptibility, electrical resistivity and heat capacity measurements. High pressure measurements using piston (25 kbar) and diamond anvil cells. Construction of calorimeter for 0.3 K to 25 K.

1978-1980: Teaching Assistant, Department of Physics, Iowa State University, Ames, Iowa.

1974-1978: B. S. (Physics), Virginia Polytechnic Institute and State University,

Blacksburg, Virginia.

Undergraduate research on microwave spectroscopy and construction of a simple mass spectrometer.

1971-1974: W. T. Woodson High School, Fairfax County, Virginia.

Honors, Awards and Society Activities

Honors, Awards and Society Activities

2007 Doctor Honoris Causa, Odessa State Academy of Refrigeration, Odessa, Ukraine

1997 Elected Full Member of the International Academy of Refrigeration, Section of Thermoelectric Cooling and Materials, St. Petersburg, Russia (the first US member)

1995 Elected Academician in the International Thermoelectric Academy, Chernovtsy, Ukraine

1994-1995 President of the International Thermoelectric Society

1991-1994 Editor of the International Thermoelectric Society Newsletter

1990 Elected to the Board of Directors of the International Thermoelectric Society

1990 Best Technical Paper Award at the IX International Conference on Thermoelectrics, March 19-21, 1990, Pasadena, California

1986 General Manager's Honors Award, General Electric Space Division

1983 G. W. Fox Memorial Award (Outstanding Research Assistant) Physics Department, Iowa State University, Ames Iowa

1981 Member of the American Physical Society (membership lapsed)

1980 Richard G. Patrick Award (Outstanding Teaching Assistant), Physics Department, Iowa State University, Ames, Iowa

1979 Member of Mensa (membership lapsed)

1977 Member of Sigma Pi Sigma (membership lapsed)

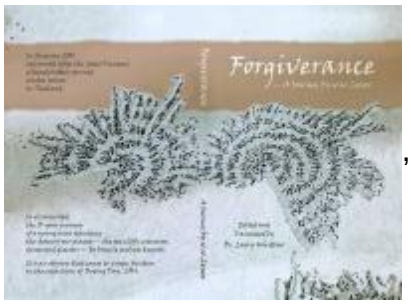
Conference Organizing and Advisory Committees

Conference Organizing and Advisory Committees

1. IX International Conference on Thermoelectrics (USA), Pasadena, California, March 19-21, 1990.
2. Modern Perspectives on Thermoelectrics and Related Materials, Materials Research Society Symposium, Anaheim, California, May 1-2, 1991.
3. XI International Conference on Thermoelectrics, Arlington, Texas, October 7-9, 1992.
4. XII International Conference on Thermoelectrics, Yokohama, Japan, November 9-11, 1993.
5. XIII International Conference on Thermoelectrics, Kansas City, Missouri, August 30-September 1, 1994.
6. XIV International Conference on Thermoelectrics, St. Petersburg, Russia, June 27-29, 1995.
7. XVI International Conference on Thermoelectrics, Dresden, Germany, August 26-29, 1997.
8. XVII International Conference on Thermoelectrics, Nagoya, Japan, May 25-28, 1998.
9. XVIII International Conference on Thermoelectrics, Baltimore, Maryland, USA, August 29-September 2, 1999.
10. 5th European Workshop on Thermoelectrics, Pardubice, Czech Republic, September 20-21, 1999
11. XX International Conference on Thermoelectrics, Beijing, P. R. China, June 8-11, 2001.
12. Next Generation Thermal Management Materials and Systems, Dallas, Texas, October 28-30, 2002. Conference Co-chair.
13. XXIII International Conference on Thermoelectrics, Adelaide, Australia, July 25-29, 2004.

Websites

- **Websites Designed, Hosted & Maintained**
  - International Thermoelectric Society [5], http://www.its.org [5]
  - MarVEL Thermoelectrics [6], large-scale thermoelectric refrigeration, http://www.marvelte.com [6]
  - Thermoelectric News, http://www.zts.com [7]

- 

, The poetry of Larry Whitlow, http://www.sandmarks.org [8] and http://www.forgiverance.com [9]

- **Websites Hosted Only (content maintained by owner)**
  - Thermion company
Thermoelectricity for Micro and Opto Electronics [10], http://www.thermion-company.com [10]

- **Conference Websites Designed & Hosted (site content authored by organizing committees)**

-
  - Annual International Conference on Thermoelectrics
    - ICT2010 Website [11]
    - ICT2009 Website [12]
    - ICT2005 Website [13]
    - ICT2003 Website [14]
    - ICT98 Website [15]
    - ICT97 Website [16]
  - Past European Conference on Thermoelectrics (ECT) Websites:
    - ECT2007 Website [17]
    - ETS2002 Website [18]
    - ETS99 Website [19]

Vining Publications

Book Chapter

[vining2005-1] Vining CB [20], Rowe DM [21], Stockholm JG [22], Rao KR [23]. History of The International Thermoelectric Society [24]. In: Rowe DM [21], editor. Thermoelectrics Handbook: Macro to Nano. Boca Raton, FL USA: CRC Press; 2005. Ap. 1:7. Abstract [25]

[davis2001-1] Davis PS [26], Barnes PA [27], Vining CB [20], Pope AL [28], Schneidmiller B [29], Tritt TM [30], et al. High temperature thermal conductivity measurements of quasicrystalline $Al_{70.8}Pd_{20.9}Mn_{8.3}$ [31]. In: Tritt T.M.; Nolas M M KGS; GD [32], editor. Thermoelectric Materials 2000 - The Next Generation Materials for Small-Scale Refrigeration and Power Generation Applications. Symposium: Materials Research Society Symposium

Proceedings. Vol 626. Warrendale, PA, USA: Mater. Res. Soc; 2001. p. Z5.4.1-7. (Thermoelectric Materials 2000 - The Next Generation Materials for Small-Scale Refrigeration and Power Generation Applications Symposium; vol 626). Abstract [33]

[vining1995-3] Vining CB [20]. Thermoelectric Properties of Silicides [34]. In: Rowe DM [21], editor. CRC Handbook of Thermoelectrics. London: CRC Press; 1995. p. 277-86.

[vining1995-2] Vining CB [20]. Silicon Germanium [35]. In: Rowe DM [21], editor. CRC Handbook of Thermoelectrics. London: CRC Press; 1995. p. 329-38.

[vining1994-3] Vining CB [20]. Structure of Insulators [36]. In: Trigg GL [37], editor. Encyclopedia of Applied Physics. Vol 8. New York: VHS Publishers; 1994. p. 85-102. Abstract [38]

[vining1993-5] Vining CB [20]. Lecture 2: Thermoelectric Fundamentals and Physical Phenomena [39]. In: Uemura K [40], editor. SCT-93 Short Course on Thermoelectrics. Yokohama-shi, Japan: International Thermoelectric Society; 1993.

[vandersande1993-1] Vandersande JW [41], Fleurial J- [42], Vining CB [20], Beaty J [43], Rolfe J [44], Klemens PG [45]. Phonon Scattering by Ultrafine Particulates in SiGe Alloys at High Temperatures [46]. In: Meisner M [47], Pohl RO [48], editors. Phonon Scattering in Condensed Matter VII. Vol 112. Berlin, Heidelberg: Springer-Verlag; 1993. p. 44-5. (Springer Series in Solid-State Sciences, Volume 112; vol 112).

[vining1992-9] Vining CB [20], Williams RM [49], Underwood ML [50], Ryan AM [51], Suitor JW [52]. Reversible thermodynamic cycle for AMTEC power conversion [53]. In: Proceedings of the 27th Intersociety Energy Conversion Engineering Conference. Vol 3. San Diego, CA, USA: IEEE, Piscataway, NJ, USA; 1992. 3.12p. 3.127. (Proceedings of the 27th Intersociety Energy Conversion Engineering Conference; vol 3). Abstract [54]

[vandersande1992-1] Vandersande JW [41], Vining CB [20], Fleurial J- [42]. Novel measurement techniques [55]. In: Horn SB [56], editor. Proceedings of the 1992 1st National Thermogenic Cooler Conference. Fort Belvoir, VA: Center for Night Vision and Electro-Optics (unpublished); 1992. p. 73-86.

[vining1992-2] Vining CB [20]. The thermoelectric limit ZT~1: Fact or Artifact [57]. In: Horn SB [56], editor. Proceedings of the 1992 1st National Thermogenic Cooler Conference. Fort Belvoir, VA: Center for Night Vision and Electro-Optics (unpublished); 1992. p. 26-9.

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[vining1990-4] Vining CB [20]. A model for the thermoelectric properties of n-type silicon-germanium alloys [61]. In: El-Genk M [62], Hoover MD [63], editors. Proceedings of the Seventh Symposium on Space Nuclear Power Systems (CONF-900109). Vol 1. Albuquerque, NM, USA: Univ. New Mexico; 1990. p. 224-8. Abstract [64]

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Silicon Germanium [65]. In: Wood C [66], editor. Proceedings of the Fifth Working Group Meeting on Thermoelectrics. Vol JPL D-3120. DARPA/TIO; 1986.

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[gshneidner1982-1] Gschneidner KA [71], Ikeda K [72], Yeh Y- [73], Beaudry BJ [74], McMasters OD [75], Vining CB [20], et al. Lattice Instability (bcctetrag. Transition) and Superconductivity in La_3S_4 Base Materials (X=S, Se) [76]. In: Buchel W [77], Weber W [78], editors. Superconductivity in d- and f-Band Metals. Karlsruhe, FRG: Kernforshungszentrum; 1982. p. 431-4.

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[vining2007-1] Vining CB [20]. ZT ~ 3.5: Fifteen Years of Progress and Things to Come [85]. In: Semenyuk V [86], editor. European Conference on Thermoelectrics, ECT2007, available at http://ect2007.its.org/system/files/u1/pdf/02.pdf. Odessa, Ukraine; 2007. Abstract [87]

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[vining1999-3] Vining CB [20]. Summarry Report on ICT'99 - The 18th International Conference on Thermoelectrics [97]. In: Fifth European Workshop on Thermoelectrics. University of Pardubice, Pardubice, Czech Republic; 1999. 7. Abstract [98] Download: Vining-ETS99-Pardubice-1999.pdf [99] (7.93 MB)

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[105], editor. Seventeenth International Conference on Thermoelectrics. Proceedings ICT98 (Cat. No.98TH8365). IEEE, Piscataway, NJ, USA; 1998. p. 370-3. Abstract [106]

[vining1998-2] Vining CB [20]. Present Status and Future Prospects for Thermoelectric Conversion [107]. In: International Symposium on Environment-Conscious Advanced Energy and Informative Materials Processing. Kyoto, Japan; 1998.

[foley1998-1] Foley JR [108], Davis PS [109], Barnes PA [110], Vining CB [20]. 3-Omega Method Poster [111].; 1998.

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[vining1997-2] Vining CB [20]. The thermoelectric process [122]. In: Tritt TM [30], Kanatzidis MG [94], Lyon H. B. J. [123], Mahan GD [92], editors. Materials Research Society Symposium Proceedings: Thermoelectric Materials - New Directions and Approaches. Vol 278. Pittsburgh, PA, USA: Mater. Res. Soc.; 1997. p. 3-13. Abstract [124]

[vining1997-1] Vining CB [20]. Damped thermoelectric waves [125]. In: Heinrich A [120], editor. Proceedings ICT'97. 16th International Conference on Thermoelectrics (Cat. No.97TH8291). IEEE, New York, NY, USA; 1997. p. 730-3. Abstract [126]

[vining1995-6] Vining CB [20]. Thermoelectric Technology of Today and Tomorrow [127]. In: The New Energies Symposium. Tokyo Institute of Technology, Tokyo, Japan; 1995. 6.

[vining1994-2] Vining CB [20]. Thermoelectric Technology of the Future [128]. ARPA Workshop on Fuel Cells/Advanced Batteries for Portable Power, La Jolla, CA USA: ZT Services; 1994. 30.

[vining1994-1] Vining CB [20]. Thermoelectric Materials of the Future [129]. In: Matsuura K [130], editor. XII International Conference on Thermoelectrics, ICT, Proceedings. Yokohama, Japan: Institute of Electrical Engineers of Japan, Tokyo; 1994. p. 126-31. (Proceedings of the 1993 12th International Conference on Thermoelectrics, ICT'93).

[vining1994-4] Vining CB [20], Fleurial J- [131]. Silicon-Germainium: An Overview of Recent Developments [132]. In: El-Genk MS [133], editor. A Critical Review of Space Nuclear Power and Propulsion 1984-1993. New York: American Institute of Physics; 1994. p. 87-120. Abstract [134]

[chmielewski1993-1] Chmielewski AB [135], Borshchevsky A [136], Vining CB [20]. Milliwatt isotope power source for microspacecraft [137]. In: El-Genk M [62], editor. American Institute of Physics Conference Proceedings: 10th Symposium on Space Nuclear Power and Propulsion , pt.2. Vol 271.; 1993. p. 765-70. Abstract [138]

[allevato1993-2] Allevato CE [139], Vining CB [20]. Thermoelectric properties of semiconducting iridium silicides [140]. In: Proceedings of the 28th Intersociety Energy Conversion Engineering Conference, IECEC-93. Vol 1. American Chem. Soc., Washington, DC, USA.; 1993. p. 239-43. Abstract [141]

[vining1993-3] Vining CB [20]. Thermoelectric Technology of Today and Tomorrow [142]. In: The New Energies Symposium. Ube, Japan; 1993. 6.

[vining1992-6] Vining CB [20], Allevato CE [139]. Progress in doping of ruthenium silicide (Ru_2Si_3) [143]. In: Proceedings of the 27th Intersociety Energy Conversion Engineering Conference (IEEE Cat. No.92CH3164-1). Vol 3. Soc. Automotive Eng., Warrendale, PA, USA.; 1992. p. 3.489-92. Abstract [144]

[vining1992-3] Vining CB [20]. Extrapolated thermoelectric figure of merit of ruthenium silicide [145]. In: Proceedings of the ninth symposium on space nuclear power systems. Vol 246. Albuquerque, New Mexico (USA): AIP; 1992. p. 338-42. Abstract [146]

[vining1992-1] Vining CB [20]. The thermoelectric limit ZT~1: Fact or Artifact [147]. In: Rao KR [23], editor. Eleventh International Conference on Thermoelectrics (ICT92). Arlington, TX USA: Univ. of Texas at Arlington, Arlington, TX; 1992. p. 223-31. (Proceedings of the 11th International Conference on Thermoelectrics, ICT'92).

[allevato1992-1] Allevato CE [139], Vining CB [20]. Phase diagram and electrical behavior of silicon-rich iridium silicide compounds [148]. In: Proceedings of the 27th Intersociety Energy Conversion Engineering Conference (IEEE Cat. No.92CH3164-1). Vol 3. Warrendale, PA, USA.: Soc. Automotive Eng.; 1992. 3.49p. 3.497. Abstract [149]

[vining1991-2] Vining CB [20]. A model for the high temperature transport properties of heavily doped p-type silicon-germanium alloys [150]. In: Allred DD [151], Vining CB [20], Slack GA [152], editors. Modern Perspectives on Thermoelectrics and Related Materials. Vol 234. Pittsburgh, PA, USA: Mater. Res. Soc.; 1991. p. 95-104. Abstract [153]

[vining1991-7] Vining CB [20], McCormack JA [154], Zoltan A [155], Zoltan LD [156]. A promising new thermoelectric material: Ruthenium silicide [157]. In: Proceedings of the eighth symposium on space nuclear power systems. Vol 217. Albuquerque, New Mexico (USA): AIP; 1991. p. 458-63. Abstract [158]

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[vining1991-2] Vining CB [20]. A model for the high temperature transport properties of heavily doped p-type silicon-germanium alloys [150]. In: Allred DD [151], Vining CB [20], Slack GA [152], editors. Modern Perspectives on Thermoelectrics and Related Materials. Vol 234. Pittsburgh, PA, USA: Mater. Res. Soc.; 1991. p. 95-104. Abstract [153]

[vining1991-4] Vining CB [20], Allevato CE [139]. Intrinsic thermoelectric properties of single crystal Ru_2Si_3 [162]. In: Rowe DM [21], editor. Proceedings of The Tenth International Conference on Thermoelectrics, ICT91. Cardiff, Wales: Babrow Press; 1991. p. 167-73.

(Proceedings of the 10th International Conference on Thermoelectrics, ICT'91).

[vining1991-5] Vining CB [20], Fleurial J- [131]. Silicon-Germainium: An Overview of Recent Developments [163]. In: Rowe DM [21], editor. Xth International Conference on Thermoelectrics. Cardiff, Wales, UK: Babrow Press; 1991. p. 1-14. Abstract [164]

[vining1990-1] Vining CB [20]. High figure of merit thermoelectrics: Theoretical considerations [165]. In: Proceedings of the Intersociety Energy Conversion Engineering Conference. Vol 2. Piscataway, NJ USA: IEEE; 1990. p. 387-91. (Proceedings of the 25th Intersociety Energy Conversion Engineering Conference - IECEC '90; vol 2). Abstract [166]

[vining1990-5] Vining CB [20]. Silicides as promising thermoelectric materials [167]. In: Vining CB [20], editor. Proceedings of the IX International Conference on Thermoelectrics (ICT90). Pasadena, CA: Jet Propulsion Laboratory; 1990. p. 249-59.

[vining1990-5] Vining CB [20]. Silicides as promising thermoelectric materials [167]. In: Vining CB [20], editor. Proceedings of the IX International Conference on Thermoelectrics (ICT90). Pasadena, CA: Jet Propulsion Laboratory; 1990. p. 249-59.

[vining1989-3] Vining CB [20], Wood C [66], Emin D [168], Aselage T [169]. Hysteresis in the Electrical Transport Properties of Boron Carbide [170]. In: Bulletin of the American Physical Society. Vol 34.; 1989. 955.

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[vining1989-7] Vining CB [20], Vandersande JW [41], Wood C [66]. Advanced materials for high-temperature thermoelectric energy conversion [173]. In: El-Genk M [62], editor. Sixth Symposium on Space Nuclear Power Systems. Albuquerque, NM; 1989. p. 421-4.

[fleurial1989-1] Fleurial JP [174], Vining CB [20], Borshchevsky A [136]. Multiple doping of silicon-germanium alloys for thermoelectric applications [175]. In: Proceedings of the 24th Intersociety Energy Conversion Engineering Conference IECEC-89. Vol 2. New York, NY, USA.: IEEE; 1989. p. 701-5. Abstract [176]

[danielson1988-1] Danienson LR [177], Alexander MN [178], Vining CB [20], Lockwood RA [179], Wood C [66]. Thermoelectric Properties of $LaTe_y$ [180]. In: Rao KR [23], editor. Seventh International Conference on Thermoelectric Energy Conversion. Arlington, TX; 1988. p. 71-5.

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[vining1986-1] Vining CB [20]. High Temperature Thermal Conductivity of Sintered Silicon Germanium Alloys [184]. In: Bulletin of the American Physical Society. Vol 31.; 1986. 277.

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[shaheen1984-1] Shaheen SA [190], Schilling JS [191], Klavins P [192], Shelton RN [79], Vining CB [20]. Magnetic Properties of $CeRh_3B_2$ Under Pressure [193]. In: Bulletin of the American Physical Society. Vol 29.; 1984. 394.

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[vining1982-1] Vining CB [20], Shelton RN [79]. Low Temperature Heat Capacity of Superconducting Ternary Iron Silicides [201]. In: Bulletin of the American Physical Society. Vol 27.; 1982. 639.

Conference Proceedings

[allred1991-1] Allred DD [151], Vining CB [20], Slack GA [152]. Materials Research Society Symposium: Modern Perspectives on Thermoelectrics and Related Materials [202]. Vol 234. Pittsburg, Pennsylvania: Materials Research Society; 1991.

[vining1990-2] Vining CB [20]. Proceedings of the IX International Conference on Thermoelectrics (ICT90) [203]. Pasadena, CA: Jet Propulsion Laboratory; 1990.

Journal Article

[vining2009-1] Vining CB [20]. An inconvenient truth about thermoelectrics [204]. Nature Materials. 2009;8:83-5. Abstract [205]

[vining2008-3] Vining CB [20]. Materials science: Half-full glasses [206]. Nature Materials. 2008;7:765-6. Abstract [207]

[vining2008-2] Vining CB [20]. Materials science: Desperately seeking silicon [208]. Nature. 2008;451:132-3. Abstract [209]

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