Tung-Sheng Kuan
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Education

1977	Ph.D.	Materials Science/Applied Physics	Cornell University, Ithaca, NY
1973	M.S.	Materials Science	Cornell University, Ithaca, NY
1970	B.S.	Physics	National Taiwan University, Taipei, Taiwan

Employment/Research Experience

Professor, Department of Physics, State University of New York at Albany	1995 to present
Visiting Professor, Department of Neurobiology, Harvard Medical School	2019 Aug.–Dec.
Visiting Faculty, Physical Science Department, IBM T. J. Watson Research Center	2001–2002
Manager, Interconnect Materials and Modeling, IBM T. J. Watson Research Center	1991–1995
Manager, Materials Structure and Properties, IBM T. J. Watson Research Center	1986–1991
Research Staff Member, IBM T. J. Watson Research Center	1977–1995

Scholarships & Honors

The Research Foundation of State University of New York – Research and Scholarship Award, 2007
The University at Albany President's Award for Excellence in Research, 2006
American Physical Society Fellow, elected 1992
IBM Corporation Invention Plateau Award, 1991
IBM Corporation Outstanding Innovation Award for discovery of long-range ordering in semiconductor alloys, 1989
Honor Society of Phi Kappa Phi, elected 1974

Current Research Interests

Size effects on electrical, mechanical, and magnetic properties of nm-thin metal films and fine lines.
High-resolution electron microscope studies of extended defects and interfaces.
Multi-scale computer simulations of mechanical and transport properties of nanostructures.
Direct observations of carrier scattering and localization in nm-thin metal films and superlattices.
High-resolution imaging of neurons and network.

Recent Professional Activities

Joint research on TEM imaging of cilia in neurons and astrocytes with Janelia Research and Harvard Medical School, Department of Neurobiology, 2019–present.
Joint research on epitaxial growth of metals on graphene with Rensselaer Polytechnic Institute, Department of Physics, 2020–present.
Principal investigator, SRC CAIST funded research on fabrication and performance limits of nanoscale Cu interconnects, 1996 –2016.
Co-principal investigator, DoD/Defense University Research Initiative on NanoTechnology (DURINT) program on nanoporous templates for large defect reduction in SiC and GaN, nanocatalysis, magnetic clusters, and biotechnology, 2001 – 06.
Co-principal investigator, DARPA/MTO funded research on increased functionality of Si through integration of SiGe films with III-V semiconductors for wireless transmitters, 2000 – 03.
Co-principal investigator, ONR funded MURI program on large area heteroepitaxial growth using compliant substrates, 1996 – 2001.

Courses Taught at SUNY-Albany

Introductory Physics I: Mechanics (APHY 140), II: Electricity and Magnetism (APHY 150), III: Modern Physics (APHY 240) and IV: Waves (APHY 250)
Classical Mechanics (APHY 330)
Quantum Physics I and II (APHY 440 and 450)

Thermodynamics and Statistical Physics (APHY 460)
Solid-State Physics I and II (APHY 487/587 and 488/588)
Statistical Mechanics (APHY 517)
Electron Diffraction and Microscopy (APHY 580)

Selected Publications (partial list)

1. The Stress-Induced Omega Phase Transformation in Ti-V Alloys, T. S. Kuan, R. R. Ahrens, and S. L. Sass, *Metall. Trans*. **6A**, 1767 (1975).
2. The Structure of a Linear Omega-Like Vacancy Defect in Zr-Nb B.C.C. Solid Solutions, T. S. Kuan and S. L. Sass, *Acta Metall*. **24**, 1053 (1976).
3. The Direct Imaging of a Linear Defect Using Diffuse Scattering in Zr-Nb B.C.C. Solid Solutions, T. S. Kuan and S. L. Sass, *Phil. Mag*. **36**, 1473 (1977).
4. Microstructure and Schottky Barrier Height of Iridium Silicides Formed on Silicon, I. Ohdomari, T. S. Kuan, and K. N. Tu, *J. Appl. Phys*. **50**, 7020 (1979).
5. Microscopic Compound Formation at the Pd-Si(111) Interface, J. L. Freeouf, G. W. Rubloff, P. S. Ho, and T. S. Kuan, *Phys. Rev. Lett*. **43**, 1836 (1979).
6. Thermal Strain in Lead Thin Films V: Strain Relaxation Above Room Temperature, M. Murakami and T. S. Kuan, *Thin Solid Films* **66**, 381 (1980).
7. Effect of Lubricant Environments on Saw Damage in Si Wafers, T. S. Kuan, K. K. Shih, J. A. Van Vechten, and W. A. Westdorp, *J. Electrochem. Soc*. **127**, 1387 (1980).
8. Strain Relaxation Mechanisms of Lead and Lead Alloy Thin Films on Silicon Substrates, M. Murakami, T. S. Kuan, and I. A. Blech, *Thin Solid Films* **89**, 165 (1982).
9. Structure of a Nb Oxide Tunnel Barrier in a Josephson Junction, T. S. Kuan, S. I. Raider, and R. E. Drake, *J. Appl. Phys*. **53**, 7464 (1982).
10. Mechanical Properties of Thin Films on Substrates, M. Murakami, T. S. Kuan, and I. A. Blech, *Treatise on Materials Science and Technology*, Vol. 24, Preparation and Properties of Thin Films, Chapter 5, Edited by K. N. Tu and R. Rosenberg, Academic Press, Inc., 1982, p. 163.
11. Low Temperature Strain Behavior of Pb Thin Films on a Substrate, T. S. Kuan and M. Murakami, *Metall. Trans*. **13A**, 383 (1982).
12. Electron Microscope Studies of a Ge-GaAs Superlattice Grown by Molecular Beam Epitaxy, T. S. Kuan and C. A. Chang, *J. Appl. Phys*. **54**, 4408 (1983).
13. Characterization of Nb/Nb Oxide Structures in Josephson Tunnel Junctions, S. I. Raider, R. W. Johnson, T. S. Kuan, R. E. Drake, and R. A. Pollak, *IEEE Transactions on Magnetics* **19**, 803 (1983).
14. Electron Microscope Studies of an Alloyed Au/Ni/Au-Ge Ohmic Contact to GaAs, T. S. Kuan, P. E. Batson, T. N. Jackson, H. Rupprecht, and E. L. Wilkie, *J. Appl. Phys*. **54**, 6952 (1983).
15. Long-Range Order in $Al_xGa_{1-x}As$, T. S. Kuan, T. F. Kuech, W. I. Wang, and E. L. Wilkie, *Phys. Rev. Lett*. **54**, 201 (1985).
16. Reactions of Pd on (100) and (110) GaAs Surfaces, T. S. Kuan, J. L. Freeouf, P. E. Batson, and E. L. Wilkie, *J. Appl. Phys*. **58**, 1519 (1985).
17. Evidence of Orientation Independence of Band Offset in AlGaAs/GaAs Heterostructures, W. I. Wang, T. S. Kuan, E. E. Mendez, and L. Esaki, *Phys. Rev.* **B 31**, 6890 (1985).
18. Crystal Orientation Dependence of Silicon Doping in Molecular Beam Epitaxial AlGaAs/GaAs Heterostructures, W. I. Wang, E. E. Mendez, T. S. Kuan, and L. Esaki, *Appl. Phys. Lett*. **47**, 826 (1985).
19. Long-Range Order in $In_xGa_{1-x}As$, T. S. Kuan, W. I. Wang, and E. L. Wilkie, *Appl. Phys. Lett*. **51**, 51 (1987).
20. Low-Temperature Selective Epitaxial Growth of Silicon at Atmospheric Pressure, T. O. Sedgwick, M. Berkenblit, and T. S. Kuan, *Appl. Phys. Lett*. **54**, 2689 (1989).
21. Growth and Properties of Thin GaAs Epitaxial Layers on Al_2O_3, T. F. Kuech, A. Segmuller, T. S. Kuan, and M. S. Goorsky, *J. Appl. Phys*., **67**, 6497 (1990).

22. Selective Growth of Silicon-Germanium Alloys by Atmospheric-Pressure Chemical Vapor Deposition at Low Temperatures, P. D. Agnello, T. O. Sedgwick, M. S. Goorsky, J. Ott, T. S. Kuan, and G. Scilla, *Appl. Phys. Lett*. **59**, 1479 (1991).
23. Strain Relaxation and Ordering in SiGe Layers Grown on (100), (111), and (110) Si Surfaces by Molecular-Beam Epitaxy, T. S. Kuan and S. S. Iyer, *Appl. Phys. Lett*. **59**, 2242 (1991).
24. Growth of Facet-Free Selective Silicon Epitaxy at Low Temperature and Atmospheric Pressure, T. O. Sedgwick, P. D. Agnello, M. Berkenblit, and T. S. Kuan, *J. Electrochem. Soc*. **138**, 3042 (1991).
25. Pulsed Laser Planarization of Metals for IC Interconnect, R. J. Baseman, T. S. Kuan, M. O. Aboelfotoh, J. C. Andreshak, F. E. Turene, R. A. Previti-Kelly, and J. G. Ryan, *Materials Research Society Symposia Proceedings*, Vol. 236, 361 (1992).
26. Silicon Epitaxy from Silane by Atmospheric-Pressure Chemical Vapor Deposition at Low Temperatures, P. D. Agnello, T. O. Sedgwick, K. C. Bretz, and T. S. Kuan, *Appl. Phys. Lett*. **61**, 1298 (1992).
27. Application of Electron and Ion Beam Analysis Techniques to Microelectronics, T. S. Kuan, P. E. Batson, R. M. Feenstra, A. J. Slavin, and R. Tromp, *IBM J. Res. Develop*. Vol. 36, No. 2, 183-207 (1992).
28. Molecular beam epitaxial heterostructures in the (311)A orientation, Y. Hsu, W. I. Wang and T. S. Kuan, *J. Vac. Sci. Technol*. B **12**(4), 2584 (1994).
29. Study of interface abruptness of molecular beam epitaxial GaAs/AlAs superlattices grown on GaAs (311) and (100) substrates, Y. Hsu, W. I. Wang, and T. S. Kuan, *J. Vac. Sci. Technol*. B **13**, 2286 (1996).
30. In-Situ Relaxed $Si_{1-x}Ge_x$ Epitaxial Layers with Low Threading Dislocation Densities Grown on Compliant Si-On-Insulator Substrates, Z. Yang, J. Alperin, W. I. Wang, S. S. Iyer, T. S. Kuan, and F. Semendy, *J. Vac. Sci. Technol.* B **16**(3), 1489 (1998).
31. Fabrication of Cu Interconnects of 50 nm Linewidth by Electron-Beam Lithography and High-Density Plasma Etching, Y. Hsu, T. E. F. M. Standaert, G. S. Oehrlein, T. S. Kuan, E. Sayre, K. Rose, K. Y. Lee, and S. M. Rossnagel, *J. Vac. Sci. Technol.* B **16**(6), 3344 (1998).
32. Dislocation Mechanisms in the GaN Lateral Overgrowth by Hydride Vapor Phase Epitaxy, T. S. Kuan, C. K. Inoki, Y. Hsu, D. L. Harris, R. Zhang, S. Gu, and T. F. Kuech, Mat. Res. Soc. Symp. Proc. Vol. 595, W2.6.1 (2000).
33. Fabrication and Performance Limits of Sub-0.1 μm Cu Interconnects, T. S. Kuan, C. K. Inoki, G. S. Oehrlein, K. Rose, Y. –P. Zhao, G. –C. Wang, S. M. Rossnagel, and C. Cabral, Mat. Res. Soc. Symp. Proc. Vol. 612, D7.1.1 (2000).
34. Compliant Substrates: A Comparative Study of the Relaxation Mechanisms of Strained Films Bonded to High and Low Viscosity Oxides, K. D. Hobart, F. J. Kub, M. Fatemi, M. E. Twigg, P. E. Thompson, T. S. Kuan, and C. K. Inoki, *J. Electronic Materials*, **29**, 897 (2000).
35. Lateral Epitaxial Overgrowth of GaSb on GaSb and GaAs Substrates by Metalorganic Chemical Vapor Deposition, S. S. Yi, D. M. Hansen, C. K. Inoki, D. L. Harris, T. S. Kuan, and T. F. Kuech, *Appl. Phys. Lett.* **77**, 842 (2000).
36. Mechanism of the Reduction of Dislocation Density in Epilayers Grown on Compliant Substrates, C. W. Pei, B. Turk, W. I. Wang, and T. S. Kuan, *J. Apply. Phys.* **12**, 5959 (2001).
37. Role of Ga flux in dislocation reduction in GaN films grown on SiC(0001), C. D. Lee, Ashutosh Sagar, R. M. Feenstra, C. K. Inoki, T. S. Kuan, W. L. Sarney, and L. Salamanca-Riba, *Appl. Phys. Lett.* **79**, 3428 (2001).
38. Semiconductor Alloys, T. S. Kuan, *Encyclopedia of Physical Science and Technology*, Third Edition, Volume 14, 599 (2002).
39. Strain Relaxation of SiGe Islands on Compliant Oxide, H. Yin, R. Huang, K. D. Hobart, Z. Suo, T. S. Kuan, C. K. Inoki, S. R. Shieh, T. S. Duffy, F. J. Kub, and J. C. Sturm, *J. Appl. Phys.* **91**, 9716 (2002).

40. Morphology and Effects of Hydrogen Etchings of Porous SiC, Ashutosh Sagar, C. D. Lee, R. M. Feenstra, C. K. Inoki, and T. S. Kuan, *J. Appl. Phys*. **92**, 4070 (2002).
41. Time development of microstructure and resistivity for very thin Cu films, S. M. Rossnagel and T. S. Kuan, *J. Vac. Sci. Technol.* A **20**(6), 1911 (2002).
42. Growth of GaN films on porous SiC substrates by molecular-beam epitaxy, F. Yun, M. A. Reshchikov, L. He, H. Morkoç, C. K. Inoki, and T. S. Kuan, *Appl. Phys. Lett.* **81**, 4142 (2002).
43. Spin-torque transfer in batch-fabricated spin-valve magnetic nanojunctions, J. Z. Sun, D. J. Monsma, T. S. Kuan, M. J. Rooks, D. W. Abraham, B. Oezyilmaz, A. D. Kent, and R. H. Koch, *J. Appl. Phys*. **93**, 6859 (2003).
44. Growth of GaN on porous SiC and GaN substrates, C. K. Inoki, T. S. Kuan, C. D. Lee, Ashutosh Sagar, R. M. Feenstra, D. D. Koleske, D. J. Diaz, P. W. Bohn, and I. Adesida, *J. Electronic Materials* **32**, 855 (2003).
45. Plasma-assisted molecular beam epitaxy of GaN on porous SiC substrates with varying porosity, Ashutosh Sagar, C. D. Lee, R. M. Feenstra, C. K. Inoki, and T. S. Kuan, *J. Vac. Sci. Technol.* B **21**(4), 1812 (2003).
46. Growth of GaN on porous SiC and GaN substrates, C. K. Inoki, T. S. Kuan, A. Sagar, C. D. Lee, R. M. Feenstra, D. D. Koleske, D. J. Diaz, P. W. Bohn, and I. Adesida, *Phys. Stat. Sol. (a)* **200**(1), 44 (2003).
47. SiGe relaxation on silicon-on-insulator substrates: An experimental and modeling study, E. M. Rehder, C. K. Inoki, T. S. Kuan, and T. F. Kuech, *J. Appl. Phys*. **94**, 7892 (2003).
48. Alteration of Cu conductivity in the size effect regime, S. M. Rossnagel and T. S. Kuan, *J. Vac. Sci. Technol.* B **22**(1), 240 (2004).
49. Formation of regular arrays of submicron GaAs dots on silicon, J. D. Beach, C. Veauvy, R. Caputo, R. T. Collins, A. A. Khandekar, T. F. Kuech, C. K. Inoki, T. S. Kuan, and R. E. Hollingsworth, *Appl. Phys. Lett.* **84**, 5323 (2004).
50. Dislocation density reduction in GaN using porous SiN interlayers, Ashutosh Sagar, R. M. Feenstra, C. K. Inoki, T. S. Kuan, Y. Fu, Y. T. Moon, F. Yun, and H. Morkoç, *Phys. Stat. Sol. (a)* **202**(5), 722 (2005).
51. Reduction of threading dislocations in GaN overgrowth by MOCVD on TiN porous network templates, F. Yun, Y. Fu, Y. T. Moon, Ü. Özgür, J. Q. Xie, S. Doğan, H. Morkoç, C. K. Inoki, T. S. Kuan, L. Zhou, and D. J. Smith, *Phys. Stat. Sol. (a)* **202**(5), 749 (2005).
52. Efficacy of single and double SiN_x interlayers on defect reduction in GaN overlayers grown by organometallic vapor-phase epitaxy, F. Yun, Y.-T. Moon, Y. Fu, K. Zhu, Ü. Özgür, H. Morkoç, C. K. Inoki, T. S. Kuan, Ashutosh Sagar, and R. M. Feenstra, *J. Appl. Phys.* **98**(12), 123502 (2005).
53. Interconnect issues post 45nm, S. M. Rossnagel, R. Wisnieff, D. Edelstein, and T. S. Kuan, *IEEE International Electron Devices Meeting, 2005. IEDM Technical Digest.*, 89 (2005).
54. Dislocation reduction in GaN grown on porous TiN networks by metal-organic vapor-phase epitaxy, Y. Fu, F. Yun, Y.-T. Moon, U. Ozgur, J. Q. Xie, X. F. Ni, N. Biyikli, H. Morkoç, Lin Zhou, David J. Smith, C. K. Inoki, and T. S. Kuan, *J. Appl. Phys.* **99**(3), 033518 (2006).
55. Damage of ultralow k materials during photoresist mask stripping process, Xuefeng Hua, Ming-shu Kuo, G. S. Oehrlein, P. Lazzeri, E. Iacob, M. Anderle, C. K. Inoki, T. S. Kuan, P. Jiang, and Wen-li Wu, *J. Vac. Sci. Technol.* B **24**(3), 1238 (2006).
56. Low dislocation densities and long carrier lifetimes in GaN thin films grown on a SiN_x nanonetwork, J. Xie, U. Ozgur, Y. Fu, X. Ni, H. Morkoç, C. K. Inoki, T. S. Kuan, J. V. Foreman, and H. O. Everitt, *Appl. Phys. Lett.* **90**, 041107 (2007).
57. Step formation on hydrogen-etched 6H-SiC[0001] surfaces, S. Nie, C. D. Lee, R. M. Feenstra, Y. Ke, R. P. Devaty, W. J. Choyke, C. K. Inoki, T. S. Kuan, and Gong Gu, *Surface Science*, **602**, 2936 (2008).
58. Dislocation mechanisms in GaN films grown on porous substrates or interlayers, T. S. Kuan and C. K. Inoki, Chapter 8 in *Porous Silicon Carbide and Gallium Nitride: Epitaxy, Catalysis, and*

Biotechnology Applications, Editors R. M. Feenstra and C. E. C. Wood, John Wiley & Sons Ltd. pp 214 – 229 (2008).
59. Defect reduction in epitaxial GaSb grown on nanopatterned GaAs substrates using full wafer block copolymer lithography, Smita Jha, C. -C. Liu, T. S. Kuan, S. E. Babcock, P. F. Nealey, J. H. Park, L. J. Mawst, and T. F. Kuech, *Appl. Phys. Lett*. **95**, 062104 (2009).
60. $InAs_yP_{1-y}$ metamorphic buffer layers on InP substrates for mid-IR diode lasers, Jeremy Kirch, Toby Garrod, Sangho Kim, Jeo H. Park, Jae C. Shin, L. J. Mawst, T. F. Kuech, X. Song, S. E. Babcock, Igor Vurgaftman, Jerry, R. Meyer, and T. S. Kuan, *J. Crystal Growth*, **312**, 1165 (2010).
61. Growth behavior and defect reduction in heteroepitaxial InAs and GaSb on GaAs using block copolymer lithography, Smita Jha, Monika K. Wiedmann, T. S. Kuan, Xueyan Song, S. E. Babcock, T. F. Kuech, *J. Crystal Growth*, **315**, 91 (2011).
62. Effects of antimony (Sb) incorporation on MOVPE grown $InAs_yP_{1-y}$ metamorphic buffer layers on InP substrates, J. Kirch, T. W. Kim, J. Konen, L. J. Mawst, T. F. Kuech, T. S. Kuan, *J. Crystal Growth*, **315**, 96 (2011).
63. Effects of nanoscale surface roughness on the resistivity of ultrathin epitaxial copper films, Yukta P. Timalsina, Andrew Horning, Robert F. Spivey, Kim M. Lewis, T. S. Kuan, G.-C. Wang, and T.-M. Lu, *Nanotechnology* **26**, 075704 (2015).
64. Uniaxial magnetic anisotropy in three-bilayer Co/Cu and Co/Al superlattices, Yaobiao Xia, Timothy Yoo, Yu Xiang, Yanli Zhang, Jiyoon Jessica Kim, Tung-Sheng Kuan and Gwo-Ching Wang, *Thin Solid Films* **681**, 32 (2019).
65. Chemical reaction induced carrier localization in nanometer-thin Al/Ru, Al/Co. and Al/Mo superlattices, Yanli Zhang, Gwo-Ching Wang, Toh-Ming Lu and Tung-Sheng Kuan, *Nanotechnology* **31** 035001 (2020).
66. Contact potential induced carrier localization in nanometer-thin Cu/Ru, Cu/Co, and Cu/Mo superlattices, Jiyoon Jessica Kim, Gwo-Ching Wang, Toh-Ming Lu, and Tung-Sheng Kuan, *J. Vac. Sci. Technol.* A **38**, 033208 (2020).
67. Near surface structure of ultrathin epitaxial Ru films on graphene/amorphous SiO_2 revealed by azimuthal RHEED, Zonghuan Lu, Neha Dhull, Xuegang Chen, Lihua Zhang, Kim Kisslinger, Tung-Sheng Kuan, Morris A. Washington, Toh-Ming Lu, Gwo-Ching Wang, *J. Materials Research*, **38**, 1224 (2023).
68. Nanoscale and wafer scale study of epitaxial Ruthenium films on amorphous SiO_2 substrate with van der Waals graphene buffer layer, Lihua Zhang, Kim Kisslinger, Zonghuan Lu, Neha Dhull, Tung-Sheng Kuan, Morris Washington, Toh-Ming Lu, and Gwo-Ching Wang, *Microscopy and Microanalysis*, **29** (Suppl 1), 2023, 1674–1675.
69. Ultrastructural differences impact cilia shape and external exposure across cell classes in the visual cortex, Carolyn M. Ott, Russel Torres, Tung-Sheng Kuan, Aaron Kuan, Joann Buchanan, Leila Elabbady, Sharmishtaa Seshamani, Agnes L. Bodor, Forrest Collman, Davi D. Bock, Wei Chung Lee, Nuno Maçarico da Costa, Jennifer Lippincott-Schwartz, *Curr Biol.* 2024 June 03; 34(11): 2418–2433.e4. doi:10.1016/j.cub.2024.04.043.