

WILLIAM WILSON MULLINS
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PUBLICATIONS

Compiled by Robert F. Sekerka*

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1. W. W. Mullins, "Magnetically Induced Grain Boundary Motion in Bismuth," *Acta Met.* **4**, 421-432 (1956).
2. W. W. Mullins, "Two Dimensional Motion of Idealized GrainBoundaries," *J. Appl. Phys.* **27**, 900-904 (1956).
3. W. W. Mullins, "The Modern Science of Materials for Electrical Engineers," Paper #CP56- 1014 AIEE Committee on Education (1956). [NO COPY]
4. W. W. Mullins, "Theory of Thermal Grooving," *J. Appl. Phys.* **28**, 333-339 (1957).
5. W. W. Mullins, "The Effect of Thermal Grooving on Grain Boundary Motion," *Acta Met.* **6**, 414-427 (1958).
6. W. W. Mullins, "Flattening of a Nearly Planar Solid Surface Due to Capillarity," *J. Appl. Phys.* **30**, 77-83 (1959).
7. W. W. Mullins and P. G. Shewmon, "The Kinetics of Grain Boundary Grooving in Copper," *Acta Met.* **7**, 163-170 (1959).
8. W. W. Mullins, "Analysis of the Linear Cooperative Problem as a Markoff Process," *Phys. Rev.* **114**, 389-393 (1959).
9. W. W. Mullins, "A Simplified Treatment of Surface Melting," *Acta Met.* **7**, 746-747 (1959).
10. W. W. Mullins, "Grain Boundary Grooving by Volume Diffusion," *Trans. AIME* **218**, 354-361 (1960).
11. W. W. Mullins, "Theory of Linear Facet Growth During Thermal Etching," *Phil. Mag.* **6**, 1313-1341 (1961).

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12. M. J. Fraser, R. E. Gold and W. W. Mullins, "Grain Boundary Mobility in Bismuth," *Acta Met.* **9**, 960-961 (1961).
13. R. T. King and W. W. Mullins, "Theory of the Decay of a Surface Scratch to Flatness," *Acta Met.* **10**, 601-606 (1962).
14. W. W. Mullins and R. F. Sekerka, "Application of Linear Programming Theory to Crystal Faceting," *J. Phys. Solids* **23**, 801-803 (1962).
15. W. W. Mullins, "Proof that the Two Dimensional Shape of Minimum Surface Free Energy is Convex," *J. Math. Phys.* **3**, 754-759 (1962).
16. J. W. Cahn and W. W. Mullins, "Discussion of J.S. Kirkaldy in Decomposition of Austenite by Diffusional Processes," Interscience Publishers, New York, 123-130 (1962).
17. W. W. Mullins, "A First Look at Metallurgy and Metallurgical Science," Pamphlet published by Pittsburgh Chapter of AIME (1962). [NO COPY]
18. W. W. Mullins and R.F. Sekerka, "Morphological Stability of a Particle Growing by Diffusion or Heat Flow," *J. Appl. Phys.* **34**, 323-329 (1963).
19. W. W. Mullins and J.P. Hirth, "The Microscopic Kinetics of Step Motion in Growth Processes:" *Int. J. Phys. Chem. Solids*, " **24**, 1391-1404 (1963).
20. W. W. Mullins, "Solid Surface Morphologies Governed by Capillarity," in *Metal Surfaces: Structure, Energetics and Kinetics*, ASM, Cleveland Ohio, 17-64 (1963).
21. W. W. Mullins and R. F. Sekerka, "The Stability of a Planar Interface During Solidification of a Dilute Binary Alloy" *J. Appl. Phys.* **35**, 444-451 (1964).
22. J. Friedel and W. W. Mullins, "The Effect of Interface Curvature on the Partitioning of Solute between Two Dilute Interstitial Solid Solutions," *Acta Met.* **12**, 759-761 (1964).
23. J. D. Grozier, H. W. Paxton and W. W. Mullins, "The Growth of Austenite into Ferrite in the Iron-Nitrogen System" *Trans. AIME* **233**, 130-142 (1965).
24. F. A. Nichols and W. W. Mullins, "Morphological Changes of a Surface of Revolution due to Capillarity-Induced Surface Diffusion," *J. Appl. Phys.* **36**, 1826-1835 (1965).
25. F. A. Nichols and W. W. Mullins, "Surface (Interface) and Volume Diffusion Contributions to Morphological Changes Driven by Capillarity," *Trans. AIME* **233**, 1840-1848 (1965).
26. E. E. Gruber and W. W. Mullins, "Extended Analysis of Surface Scratch Smoothing," *Acta Met.* **14**, 397-403 (1966).
27. J. E. Pavlick, W. W. Mullins and H. W. Paxton, "The Growth of Nitrogen-Austenite into Alloyed Ferrite," *Trans. AIME* **236**, 875-881 (1966).

28. E. E. Gruber and W. W. Mullins, "On the Theory of Anisotropy of Crystalline Surface Tension:" J. Phys. Chem. Solids **28**, 875-887 (1967).
29. *Metal Transformations*, W. W. Mullins and M. C. Shaw, eds., Gordon and Breach, New York (1968). [NO COPY]
30. R. L. Klueh and W. W. Mullins, "Some Observations on Hydrogen Embrittlement of Silver," Trans. Met. Soc. of AIME **242**, 237-243 (1968).
31. R. L. Klueh and W.W. Mullins, "Periodic Precipitation (Liesegang Phenomenon) in Solid Silver: I. Experimental," Acta Met. **17**, 59-67 (1969).
32. R. L. Klueh and W. W. Mullins, "Periodic Precipitation (Liesegang Phenomenon) in Solid Silver: II. Modification of Wagner's Mathematical Analysis:" Acta Met. **17**, 69-76 (1969).
33. W. W. Mullins, "Stochastic Theory of Particle Flow under Gravity," J. Appl. Phys. **43**, 665-678 (1972).
34. W. W. Mullins, "Diffusion with Stochastic Jump Times," AJP **41**, 264-268 (1973).
35. W. W. Mullins, "Experimental Evidence for the Stochastic Theory of Particle Flow Under Gravity," Powder Technology **9**, 29-37 (1974).
36. W. W. Mullins, "Nonsteady-State Particle Flow Under Gravity-An Extension of the Stochastic Theory," J. Appl. Mech. **41**, 867-872 (1974).
37. W. W. Mullins, "An Estimator of the Underlying Size Distribution of Overlapping Impact- Craters," Icarus **29**, 113-123 (1976).
38. W. W. Mullins, "Stochastic Modeling of Gravity Induced Particulate Flow," in *Probability Theory and Reliability Analysis in Geotechnical Engineering*, D.A. Grivas, ed., National Science Foundation and Rensselaer Polytechnic Institute, p. 36 (1977). [PREPRINT ONLY]
39. R. F. Quick, Jr., W.W. Mullins and T.A. Reichert, "Spatial Summation Effects on Two- Component Grating Thresholds," J. Opt. Soc. Am. **68** 116-121 (1978).
40. W. W. Mullins, "Use of Equivalency in Estimating the Historical Size Distribution of Impact Craters," Icarus **33**, 624-629 (1978).
41. R. F. Quick Jr., W. W. Mullins and R. N. Lucas, "Contrast Thresholds of Random Patterns," Photographic Science and Engineering **22**, 72-75 (1978).
42. W. W. Mullins, "A Convexity Theorem for Subthreshold Stimuli in Linear Models of Visual Contrast Detection," J. Opt. Soc. Am. **68**, 456-459 (1978).
43. W. W. Mullins, "Critique and Comparison of Two Stochastic Theories of Gravity-Induced Particle Flow," Powder Technology **23**, 115-119 (1979).

44. W. W. Mullins, "Variational Principles and Bounds for the Conductance of a Heterogeneous, Locally Anisotropic Body," *J. Appl. Phys.* **50**, 6754-6760 (1979).
45. R.F. Sekerka and W. W. Mullins, "Proof of the Symmetry of the Transport Matrix for Diffusion and Heat Flow in Fluid Systems," *J. Chem. Phys.* **73**, 1413-1421 (1980).
46. W. W. Mullins and R. F. Sekerka, "On the Validity of the Onsager Reciprocal Relations," *Scripta Met.* **15**, 29-33 (1981).
47. W. W. Mullins, "The Thermodynamics of Crystal Phases with Curved Interfaces: Special Case of Interface Isotropy and Hydrostatic Pressure," *Proc. Int. Conf. on Solid-Solid Phase Transformations*, H. I. Aaronson, D. E. Laughlin, R. F. Sekerka and C. M. Wayman, eds. TMS-AIME, Warrendale, PA, 49-66 (1982).
48. W. W. Mullins, "Thermodynamic Equilibrium of a Crystalline Sphere in a Fluid," *J. Chem. Phys.* **81**, 1436-1442 (1984).
49. W. W. Mullins and R. F. Sekerka, "On the Thermodynamics of Crystalline Solids," *J. Chem. Phys.* **82**, 5192-5202 (1985).
50. W. W. Mullins, "The Statistical Self-Similarity Hypothesis in Grain Growth and Coarsening," *J. Appl. Phys.* **59**, 1341-1349 (1986).
51. J. A. Barnard, P. Wynblatt, W. C. Johnson and W. W. Mullins, "A Comparison of Solid and Liquid Alloys," *Mat. Res. Soc. Symp. Proc.*, **83** 67-74 (1987).
52. J. A. Barnard, P. Wynblatt, W. C. Johnson and W. W. Mullins, "Surface Segregation in In-Pb Alloys: Solid and Liquid States," *Surface Sci.* **183**, 134-146 (1987).
53. W. W. Mullins, "A Markov Treatment of the Self-Diffusion Dyadic in Homogeneous Crystals," *J. Appl. Phys.* **64**, 3918-3927 (1988).
54. W. W. Mullins, "On Idealized Two Dimensional Grain Growth," *Scripta Metall.* **22**, 1441-1444 (1988).
55. W. W. Mullins and Jorge Viñals, "Self-Similarity and Growth Kinetics Driven by Surface Free Energy Reduction," *Acta Metall.* **37**, 991-997 (1989).
56. W. W. Mullins, "Estimation of the Geometrical Rate Constant for Idealized Three Dimensional Grain Growth," *Acta Metall.* **37**, 2979-2984 (1989).
57. P. Leo, W. W. Mullins, R. F. Sekerka, J. Viñals, "Effect of Stress on Late Stage Coarsening," *Acta Metall.* **38**, 1573-1580 (1990).
58. W. W. Mullins, "A One Dimensional Nearest Neighbor Model of Coarsening," *Proceedings of the Calculus of Variations and Nonlinear Material Behavior*, Carnegie Mellon University (1990). [PREPRINT ONLY]

59. W. W. Mullins, "A One Dimensional Stochastic Model of Coarsening," in *On the Evolution of Phase Boundaries*, **43** of the series Institute for Mathematics and Its Applications (U. of Minn.), M.E. Gurtin and G.B.McFadden, eds., Springer-Verlag, p.101, (1991). [PREPRINT ONLY]
60. W. W. Mullins, "Statistical Particle Growth Law in Self-Similar Coarsening," *Acta Metall.* **39**, 2081-2090 (1991).
61. W. W. Mullins, "Macroscopic Description of Interface Migration by Ledge and Kink Motion Controlled by Volume Diffusion," *Met. Trans.* **22A**, 1225-1233 (1991).
62. C. Atkinson, M. Enomoto, W. W. Mullins and R. Trivedi, "Report on Panel Discussion II: Critical Problems in the Mathematics of Ledgewise Growth", *Met. Trans. A* (June 1991). [NO COPY]
63. W.W. Mullins and Jorge Viñals, "Scaling in a Binary Linear Bubble Model of Grain Growth," in *Proceedings of the International Conference on Grain Growth in Polycrystalline Materials*, Rome (1991), G. Abbruzzese and P. Brozzo, eds., Trans. Tech. Publications, Zurich (1992). [PREPRINT ONLY]
64. F.Y. Génin, W.W. Mullins and P.Wynblatt, "Capillary Instabilities in Thin Films: A Model of Thermal Pitting at Grain Boundaries," *Acta metall. et mater.* **40**, 3239-3248 (1992)
65. J.M. Rickman, Jorge Viñals, R.F. Sekerka and W.W. Mullins, "Effects of Long-Range Crystalline Order on Collective Diffusion in Binary Solids," *Phys. Rev.* **B45**, 7750-7761 (1992).
66. C.L. Bauer and W.W. Mullins, "On the theory of steady-state electromigration in thin films," *Appl. Phys. Lett.* **61**, 2987-2989 (1992).
67. W.W. Mullins and Jorge Viñals, "Scaling in Linear Bubble Models of Grain Growth" *Acta metall. et mater.* **41**, 1359-1367 (1993).
68. F.Y. Génin, W.W.Mullins and P.Wynblatt, "The Effect of Stress on Grain Boundary Grooving," *Acta metall. et mater.* **41**, 3541-3547 (1993).
69. W.W. Mullins, "Idealized two Dimensional Sintering by Interface Diffusion," *Scripta metall. et mater.* **29**, 491-496 (1993).
70. M. Scherge, C. L. Bauer and W. W. Mullins "Stress Distribution and Mass Transport along Grain Boundaries during Steady-State Electromigration," *Proceed. Spring Mat. Res. Soc. Symp.* **38**, 341-352 (1994).
71. M. Scherge, C. L. Bauer and W. W. Mullins "Stress Distribution and Mass Transport along Grain Boundaries during Steady-State Electromigration," *Acta metall. et mater.* **43**, 3525-3538 (1995).

72. A Brokman, R. Kris, W.W. Mullins and A.J. Vilenkin, "Steady-state motion of grain boundary grooves," *Scripta met et mater.* **32**, 1341-1346 (1995). [NO COPY]
73. W. W. Mullins, "Mass Transport at Interfaces in Single Component Systems (Institute of Metals Mehl Memorial Lecture)," *Metall. Trans.* **26A**, 1917-1929 (1995).
74. L. M. Klinger, E. E. Glickman, V. E. Fradkov, W. W. Mullins and C. L. Bauer, "Extensions of thermal grooving for arbitrary grain-boundary flux," *J. Appl. Phys.* **78**, 3833-3838 (1995).
75. L. M. Klinger, E. E. Glickman, V. E. Fradkov, W. W. Mullins and C. L. Bauer, "Effect of surface and grain-boundary diffusion on interconnect reliability," in *Materials Reliability in Microelectronics V, MRS Symp. Proc.* **391**, 295 (1995).
76. P.J. Kung, M. E. McHenry, M. P. Maley, P.H. Kes, D.E. Laughlin and W. W. Mullins, "Critical-current anisotropy, intergranular coupling, and effective pinning energy in $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta}$ single crystals and Ag sheathed $(\text{Bi,Pb})_2\text{Sr}_2\text{CaCu}_3\text{O}_{10+\delta}$ tapes," *Physica C: Superconductivity* **249** 53-68 (1995). [NO COPY]
77. H. Bonzel and W. W. Mullins, "Smoothing of perturbed vicinal surfaces," *Surface Science* **350**, 285-300 (1996).
78. S. Surnev, B. Voigtlaender, H.P. Bonzel and W. W. Mullins, "Anisotropic profile decay on perturbed Au(111) vicinal surfaces," *Surface Science* **360**, 242-248 (1996). [NO COPY]
79. L. Klinger, X. Chu, C. L. Bauer and W. W. Mullins, "Grain Boundary Slit Propagation in an Electric Field," *J. Appl. Phys.* **80**, 6670-6676 (1996).
80. C. Duport, A. Chame, W. W. Mullins and J. Villain, "Decay of Grooves Cut in a Surface with Singular Orientation when the Neighboring Orientations are Unstable," *J. Phys. I France* **6**, 1095-1125 (1996).
81. W. W. Mullins, "Remarks on the Evolution of Materials Science (Von Hippel Award Address)," *MRS Bulletin* July 20-27 (1996).
82. S. Surnev, P. Coenen, H. P. Bonzel and W. W. Mullins, "Surface Morphologies-Equilibria and Transient States, *Progress in Surface Science* **53** 287-296 (1996). [NO COPY]
83. A. D. Rollett and W. W. Mullins, "On the Growth of Abnormal Grains, *Scripta mater.* **36**, 975-980 (1997).
84. X. Chu, C. L. Bauer and W. W. Mullins, "Spreading of a Void along a Singular Surface during Electromigration: A Failure Mode," *APL* **70**, 194-196 (1997).
85. X. Chu, C. L. Bauer and W. W. Mullins and L. Klinger, "The Spreading of a Void at the Leading Surface during Electromigration," *MRS Symp. Proc.* **472**, 3-13 (1997).

86. C. Duport, Anna Chame, W. W. Mullins and J. Villain, "Smoothing of a grooved singular surface whose neighboring orientations are unstable," in *Dynamics of Crystal Surfaces and Interfaces*, P. M. Duxbury and T. J. Pence eds., Plenum Press, 71 (1997). [NO COPY]
87. B. Adams, S. Costiner, D. Kinderleher and W.W. Mullins, "Extracting the grain-boundary character/free-energy relationship from the microstructure of pure $\langle 111 \rangle$ and $\langle 100 \rangle$ tilt boundaries," MRS **472** 105-111 (1997).[NO COPY]
88. B. Adams, D. Kinderlehrer, W. W. Mullins, A. D. Rollett and S. Taasan, "Extracting the Relative Grain Boundary Free Energy and Mobility Functions from the Geometry of Microstructures," Scripta mater. **38**, 531-536 (1998). [NO COPY]
89. J. Viñals and W. W. Mullins, "Self-Similarity and Coarsening of Three Dimensional Particles on a One or Two Dimensional Matrix," J. Appl. Phys. **83**, 621-628 (1998).
90. W. W. Mullins, "Curvature Driven Grain Growth of Uniform Boundaries with Scaling," Proceedings of the International Conference on Grain Growth (1998). [NO COPY]
91. W. W. Mullins, "Grain Growth of Uniform Boundaries with Scaling," Acta mater. **46**, 6219-6226 (1998).
92. A. D. Rollett, C.-C. Yang and W. W. Mullins, "Measurement of Triple Junction Geometry for Extraction of Grain Boundary Energies," Proceedings of the International Conference on Grain Growth, Minerals, Metals & Materials Society 349-358 (1998).
93. W. W. Mullins, "Models of Idealized Grain Growth: Critique of Stochastic Theories and Implications of Scaling," Proceedings of the International Conference on Grain Growth, Minerals, Metals & Materials Society, 3-11 (1998).
94. H. Groenzin, O. C. Mullins and W. W. Mullins, "Resonant Fluorescence Quenching of Aromatic Hydrocarbons by Carbon Disulfide," J. Phys, Chem. **A103**, 1504-1508 (1999).
95. B. L. Adams, S. Ta'asan, D. Kinderleher, I. Livshits, D. Mason, C. Wu, W. W. Mullins, G. S. Rohrer, A. D. Rollett and D. Saylor, "Extracting grain boundary energy from triple junction measurement," Interface Science **7** 321-338 (1999). [NO COPY]
96. C. S. Smith and W. W. Mullins, "Robert Franklin Mehl 1898-1976, A Biographical Memoir," National Academy of Sciences, National Academy Press, Washington, D.C., Biographical Memoirs **78** 129-145 (2000)
97. G.S. Rohrer, C.L. Rohrer, and W.W. Mullins, "Nucleation Energy Barriers for Volume Conserving Shape Changes of Crystals with Nonequilibrium Morphologies," J. Amer. Ceram. Soc. **84**, 2099-2104 (2001). [NO COPY]

98. W.W. Mullins, "Capillary-Induced Surface Morphologies," *Interface Science* **9**, 7-18 (2001).
99. G.S. Rohrer, C.L. Rohrer, and W.W. Mullins, "Nucleation Energy Barriers for Volume Conserving Shape Changes of Crystals with Nonequilibrium Morphologies," *J. Amer. Ceram. Soc.* **84** 2099-2104 (2001).[PREPRINT ONLY]
100. C.-C. Yang, A. D. Rollett and W. W. Mullins, "Measuring Relative Grain Boundary Energies and Mobilities in an Aluminum Foil from Triple Junction Geometry," *Scripta Met.* **44**, 2735-2740 (2001).
101. G. S. Rohrer and W. W. Mullins, "Energy Barriers for the Morphological Evolution and Coarsening of Faceted Crystals," *Proceedings of the First Joint International Conference on Grain Growth*, G. Gottstein and D.A. Molodov eds., Springer Verlag (2001) 321-326. [PREPRINT ONLY]
102. G.S. Rohrer, C.L. Rohrer, and W.W. Mullins, "Coarsening of Faceted Crystals, " *J. Amer. Ceram. Soc.* **85**, 675-682 (2002).
103. W.W. Mullins and J. Viñals, "Linear bubble model of abnormal grain growth," *Acta Materialia* **50**, 2945- 2954 (2002).