

University of Groningen

On the role of dislocations in fatigue crack initiation

Brinckmann, Steffen

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2005

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Brinckmann, S. (2005). *On the role of dislocations in fatigue crack initiation*. [Thesis fully internal (DIV), Groningen]. s.n.

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

References

- [1] A. Wöhler. *Über die Festigkeitsversuche mit Eisen und Stahl*. Verlag von Ernst & Korn, Berlin, 1870.
- [2] H.H.M. Cleveringa, E. Van der Giessen, and A. Needleman. A discrete dislocation analysis of mode I crack growth. *Journal of the Mechanics and Physics of Solids*, 48:1133–1157, 2000.
- [3] V.S. Deshpande, A. Needleman, and E. Van der Giessen. Discrete dislocation modelling of fatigue crack propagation. *Acta Materialia*, 50:831–846, 2002.
- [4] H. Mughrabi, F Ackermann, and K. Herz. Persistent slip bands in fatigued face-centered and body-centered cubic metals. In *Fatigue Mechanisms*, Special Technical Publication 675, pages 69–105. Philadelphia: American Society for Testing and Materials, 1979.
- [5] Z. S. Basinski and S. J. Basinski. Low amplitude fatigue of copper single crystals - II. surface observations. *Acta Metallurgica*, 33:1307–1317, 1985.
- [6] J.C. Grosskreutz and H. Mughrabi. *Constitutive Equations in Plasticity*, page 301. Cambridge, Massachusetts: MIT Press, 1975. edited by A.S. Argon.
- [7] U. Essmann, U. Gösele, and H. Mughrabi. A model of extrusions and intrusions in fatigued metals - I. point-defect production and the growth of extrusions. *Philosophical Magazine A*, 44:405–426, 1981.
- [8] J. Ahmed, A.J. Wilkinson, and S.G. Roberts. Electron channeling contrast imaging characterization of dislocation structures associated with extrusion and intrusion systems and fatigue cracks in copper single crystals. *Philosophical Magazine A*, 81(6):1473–1488, 2001.
- [9] H. Mughrabi. Dislocation wall and cell structures and long-range internal stresses in deformed metal crystals. *Acta Metallurgica*, 31:1367–1379, 1983.

- [10] Z. S. Basinski and S. J. Basinski. Low amplitude fatigue of copper single crystals - III. PSB sections. *Acta Metallurgica*, 33:1319–1327, 1985.
- [11] H.N. Hahn and D.J. Duquette. The effect of surface dissolution on fatigue deformation and crack nucleation in copper and copper 8% aluminum single crystals. *Acta Metallurgica*, 26:279–287, 1978.
- [12] B.T. Ma and C. Laird. Overview of fatigue behavior in copper single crystals - II. population, size distribution and growth kinetics of stage I cracks for tests at constant strain amplitude. *Acta Metallurgica*, 37:337–348, 1989.
- [13] H. Vehoff. *Rissbildung und Rissausbreitung in Ein- und Bikristallen*. VDI Verlag, 1994.
- [14] J. Kratochvil. Self-organization model of localization of cyclic strain into PSBs and the formation of dislocation wall structures. *Materials Science and Engineering A*, pages 331–335, 2001.
- [15] P. Neumann. Coarse slip model of fatigue. *Acta Metallurgica*, 17:1219–1225, 1969.
- [16] N.F. Mott. A theory of the origin of fatigue cracks. *Acta Metallurgica*, 6:195–197, 1958.
- [17] J. G. Antonopoulos, L. M. Brown, and A. T. Winter. Vacancy dipoles in fatigued copper. *Philosophical Magazine*, 34:549–563, 1976.
- [18] E.A. Repetto and M. Ortiz. A micromechanical model of cyclic deformation and fatigue-crack nucleation on f.c.c. single crystals. *Acta Materialia*, 45:2577–2595, 1997.
- [19] K. Differt, U. Essmann, and H. Mughrabi. A model of extrusions and intrusions in fatigued metals - II. surface roughening by random irreversible slip. *Philosophical Magazine A*, 54:237–258, 1986.
- [20] L. M. Brown and S. L. Ogin. Role of internal stresses in the nucleation of fatigue cracks. In Willis Bilby, Miller, editor, *Fundamentals of deformation and fracture*, pages 501–528. Eshelby memorial symposium, 1984.
- [21] E.W. Johnson and H.H. Johnson. Imperfection density of fatigued and annealed copper via electrical-resistivity measurements. *Transactions of the metallurgical society of AIME*, 233:1333–1339, 1965.
- [22] O. Helgeland. Resistivity studies of defect concentrations resulting from cyclic stressing of copper single crystals at room temperature. *Transactions of the metallurgical society of AIME*, 239:2001–2002, 1967.

- [23] A.K. Eikum and I. Holwech. Recovery on copper after fatigue at $78^{\circ}k$. *Scripta Metallurgica*, 2:605–610, 1968.
- [24] J. Polák. The effect of intermediate annealing on the electrical resistivity and shear stress of fatigued copper. *Scripta Metallurgica*, 4:761–764, 1970.
- [25] W. Kromp and B. Weiss. Electrical resistivity of copper after high frequency fatigue (ultrasonic fatigue at 20 khz). *Scripta Metallurgica*, 5:499–504, 1971.
- [26] W. Kromp and B. Weiss. Recovery of electrical resistivity of copper after high frequency fatigue (ultrasonic fatigue at 20 khz). *Scripta Metallurgica*, 5:505–510, 1971.
- [27] A.A. Benzerga, Y. Bréchet, A. Needleman, and E. Van der Giessen. Incorporating three-dimensional mechanisms into two-dimensional dislocation dynamics. *Modelling and Simulation in Materials Science and Engineering*, 12:159–196, 2004.
- [28] E. Van der Giessen and A. Needleman. Discrete dislocation plasticity: a simple planar model. *Modelling and Simulation in Materials Science and Engineering*, 3:689–735, 1995.
- [29] X.P. Xu and A. Needleman. Numerical simulations of fast crack growth in brittle solids. *Journal of the Mechanics and Physics of Solids*, 42:1397–1434, 1994.
- [30] L. B. Freund. The mechanics of dislocations in strained-layer semiconductor materials. *Advances in Applied Mechanics*, 30:1–66, 1994.
- [31] J. P. Hirth and J. Lothe. *Theory of Dislocations*. New York: McGraw–Hill, 1968.
- [32] R. D. McCammon and H.M. Rosenberg. The fatigue and ultimate tensile strength of metals between 4.2 and $293^{\circ}k$. In *Proceedings of the Royal Society London*, volume A242, pages 203–211, 1957.
- [33] H.H.M. Cleveringa, E. Van der Giessen, and A. Needleman. A discrete dislocation analysis of bending. *International Journal of Plasticity*, 15:837–868, 1999.
- [34] J.C. Figueroa and C. Laird. Crack initiation mechanisms in copper polycrystals cycled under constant strain amplitudes and in step tests. *Materials Science and Engineering*, 60:45–58, 1983.
- [35] S. Zaeferrer. New developments of computer-aided crystallographic analysis in transmission electron microscopy. *Journal of Applied Crystallography*, 33:10–25, 2000.
- [36] L. Greengard and V. Rokhlin. *Journal of computational Physics*, 73:325, 1987.
- [37] H.Y. Wang and R. LeSar. $O(N)$ algorithm for dislocation dynamics. *Philosophical Magazine A*, 71(1):149–164, 1995.

- [38] V.S. Deshpande, Y. Bréchet, A. Needleman, and E. Van der Giessen. Dislocation dynamics is chaotic. *Scripta Materialia*, 45:1047–1053, 2001.
- [39] D. Weygand, L.H. Friedman, E. Van der Giessen, and A. Needleman. Aspects of boundary-value problem solutions with three-dimensional dislocation dynamics. *Modelling and Simulation in Materials Science and Engineering*, 10:437–468, 2002.
- [40] W.M. Lomer. A dislocation reaction in the face-centred cubic lattice. *Philosophical Magazine*, 42:1327–1331, 1951.
- [41] S. Suresh. *Fatigue of Materials*. Cambridge UK: Cambridge University Press, 2 edition, 1998.
- [42] G.P. Zhang, R. Schwaiger, C.A. Volkert, and O. Kraft. Effect of film thickness and grain size on fatigue-induced dislocation structures in cu thin films. *Philosophical magazine letters : physics of condensed matter*, 83(8):477–484, 2003.
- [43] H. Mughrabi, R. Wang, K. Differt, and U. Essmann. Fatigue crack initiation by cyclic slip irreversibilities in high-cycle fatigue. In J. Langfort, D.L. Davidson, W.L. Morris, and R.P. Wei, editors, *Quantitative Measurement of Physical Damage*, Special Technical Publication 811, pages 5–45. Philadelphia, PA: American Society for Testing and Materials, 1983.
- [44] W.H. Kim and C. Laird. Crack nucleation and stage I propagation in high strain fatigue – II. mechanism. *Acta Metallurgica*, 26:789–799, 1978.
- [45] K. Katagiri, A. Omura, K. Koyanagi, J. Awatani, T. Shiraishi, and H. Kanerhiro. Early stage crack tip morphology in fatigued copper. *Metallurgical Transactions*, 8A:1769–1773, 1977.
- [46] L. M. Brown. Dislocations and the fatigue strength of metals. In Hartley Ashby, Bulough and Hirth, editors, *Proceedings of the International Conference on Dislocation Modeling of Physical Systems*, pages 51–68. New York: Pergamon Press, 1980.
- [47] M.L. Falk, A. Needleman, and J.R. Rice. A critical evaluation of cohesive zone models of dynamic fracture. *Journal de Physique IV*, 11:43–50, 2001. Proceedings to the 5th European Mechanics of Materials Conference.
- [48] M. Peet. Strength of materials. <http://mathewpeet.org/science/materials/strength>.
- [49] V.S. Deshpande, A. Needleman, and E. Van der Giessen. Finite strain discrete dislocation plasticity. *Journal of the Mechanics and Physics of Solids*, 51:2057–2083, 2003.
- [50] D. Gross and T. Seelig. *Bruchmechanik*. Springer Verlag, 3 edition, 2001.

- [51] R.V. Kukta and K. Bhattacharya. A micromechanical model of surface steps. *Journal of the Mechanics and Physics of Solids*, 50:615–649, 2002.
- [52] V.I. Marchenko and A.Y. Parshin. Elastic properties of crystal surfaces. *Sov. Phys. JETP*, 52:129–131, 1980.
- [53] P.J.E. Forsyth. Extrusion of material from slip bands at the surface of fatigued crystals of an aluminium-copper alloy. *Nature*, 171:172–173, 1955.
- [54] A. H. Cottrell, F.R.S. Hull, and D. Hull. Extrusion and intrusion by cyclic slip in copper. In *Proceedings of the Royal Society London*, volume A242, 1957.
- [55] S. Brochard, P. Beauchamp, and J. Grilhé. Stress concentration near a surface step and shear localization. *Physical Review B*, 61:8707–8713, 2000.
- [56] S. Timoshenko and J.N. Goodier. *Theory of Elasticity*. McGraw-Hill, New York, 2 edition, 1961.
- [57] T.L. Anderson. *Fracture Mechanics*. CRC Press, 2 edition, 1995.
- [58] J.H. Rose, J. Ferrante, and J.R. Smith. Universal binding energy curves for metals and bimetallic interfaces. *Physical Review Letters*, 47:675–678, 1981.

