



G. Gottstein · D. A. Molodov (Eds.)

Recrystallization and Grain Growth

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Edited by
Günter Gottstein and Dmitri A. Molodov



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Preface

During heat treatment of crystalline solids recrystallization (ReX) and grain growth (GG) are the major processes that modify the granular microstructure besides phase transformations. Owing to their strong impact on material properties and subsequent processing these phenomena have been extensively investigated in the past with the first publication on ReX dating back to 1881, i.e. more than 100 years ago and at the same time Lord Kelvin (then Sir William Thompson) studies soap froth to determine curved interfaces and optimum position of space.

A huge amount of data has been collected in particular on *ReX&GG* of commercial alloys, and the fundamental underlying phenomena have been identified. Nevertheless, despite of all these efforts, there remains a substantial lack of understanding of the essential mechanisms of ReX and GG. This is mainly due to two reasons:

- a) *ReX&GG* are not equilibrium phase transformations and, therefore, do not comply with equilibrium thermodynamics. Rather they are microstructural instability phenomena and, therefore, subject of reversible thermodynamics in terms of entropy production.
- b) Instability phenomena proceed from locations which are untypical for the average microstructure of the material. In fact homogeneous microstructures strongly resist recrystallization and markedly slow down grain growth. The crucial microstructural features for nucleation of recrystallization have, in principle, been identified but their mechanisms are not understood. Equally the growth of recrystallized or coarsening grains are commonly perceived as grain boundary motion in a homogeneous environment, which may be far from the truth. Only very recently it was demonstrated that in connected grain boundary systems there are also other microstructural elements that may play an essential role, like grain boundary junctions which are comparable in number to the frequency of grain boundaries. Another issue is the entire negligence of the role of internal stresses on nucleation of recrystallization and grain boundary migration, and until recently, high angle grain boundaries were tacitly assumed not to couple with mechanical stresses at all and, therefore, to remain unaffected by internal stresses except for the stored dislocation energy acting as thermodynamic driving force for recrystallization.

Owing to an insufficiently deep understanding of *ReX&GG* and, therefore, the inability of making reliable predictions on microstructure evolution, in particular crystallographic texture, during heat treatment of deformed materials, this research field was essentially dormant for decades, and the collection of data bases rather than the development of predictive power was the guideline of materials producers.

In the beginning of the 1990's interest in this field was suddenly rekindled in particular due to the development of novel research tools, like high resolution

TEM, orientation mapping by EBSD, and computer simulation owing to the availability of high performance computers and new theoretical concepts of microstructure modeling.

Besides workshops and topical conferences like the RISØ International Symposium, International conferences on ReX and GG were initiated separately in Wollongong, Australia (1990) and Rome (1991), respectively. Conferences on ReX followed in San Sebastian, Spain (1992), Monterey, USA (1996), and Tsukuba, Japan (1999). The Rome conference on GG was succeeded by ICGG-2 in Kitabyushu, Japan (1995) and ICGG-3 in Pittsburgh, USA (1998).

While the ReX conferences were more strongly oriented towards applications, the GG conferences focussed on the scientific aspects of the evolution and behavior of granular microstructures. The complementarity of both approaches attracted essentially the same core audience so that both conference series decided not to merge but to have a joint conference with common sessions of general interest and specific topical sessions on the core issues of both conference series. The contributions to these proceedings are the manuscripts presented in both conferences and are designed to provide both, a general but comprehensive review and detailed information on current research in *ReX&GG*.

We hope the reader will find valuable information to guide his own work or to acquaint him with new concepts and modern issues in *ReX&GG*.

G. Gottstein and D.A. Molodov

Aachen, August 2001

CONTENTS

VOLUME ONE

Opening Address

Main Steps in the Development of the Statistical Theory of Grain Growth
K. Lücke3

Keynote Papers

External Field Applied Grain Boundary Engineering for High Performance Materials
T. Watanabe11

Grain Boundary Character – a Key Factor for Grain Boundary Control
D.A. Molodov21

Modelling Microstructure Development in Annealing and Deformation
P. Bate39

Recrystallization and Grain Growth Textures in Low Carbon Steels
J.J. Jonas and L. Kestens49

High-Temperature Structure and Properties of Grain Boundaries by Molecular-Dynamics Simulation
D. Wolf, V. Yamakov, P. Keblinski, S.R. Phillpot and H. Gleiter61

Experimental Measurements of Nucleation and Growth Rates
D. Juul Jensen73

Recrystallization and Grain Growth in Minerals: Recent Developments
J.L. Urai and M. Jessell87

Grain Growth

Invited Papers

Topological Relationships in 2D Trivalent Mosaics (Topological Metallography)
R. Brandt, K. Lücke, G. Abbruzzese and J. Svoboda101

Abnormal Grain Growth – Some Theoretical and Practical Considerations

P.R. Rios115

Numerical Modelling of Grain Growth : Current Status

C. Maurice123

Vacancy Effects in Grain Growth

Y. Estrin135

Grain Growth Phenomena during Steel Processing

I. Gutierrez, B. Lopez and J.M. Rodriguez-Ibabe145

Aspects on Grain Growth in Cemented Carbides and Cermets

T. Yamamoto, Y. Ikuhara and T. Sakuma155

Grain Boundary Property Determination through Measurement of Triple Junction Geometry and Crystallography

*A.D. Rollett, C.-C. Yang, W.W. Mullins, B.L. Adams,
C.T. Wu, D. Kinderlehrer, S. Ta'asan, F. Manolache,
C. Liu, I. Livshits, D. Mason, A. Talukder, S. Ozdemir,
D. Casasent, A. Morawiec, D. Saylor, G.S. Rohrer,
M. Demirel, B. El-Dasher and W. Yang*165

Triple Junction Motion in Metals

*L.S. Shvindlerman, G. Gottstein, D.A. Molodov and
V.G. Sursaeva*177

Grain Boundary Mechanics

M. Winning193

Grain-Growth Kinetics and Thermal Stability of Nanocrystalline Materials

C.E. Krill III and R. Birringer205

Producing Ultra Fine Grain Structure in Large Scale Billets

O.A. Kaibyshev219

Fundamentals, Modeling and Simulation of Grain Growth

Computer Simulation of Grain Growth Based on Orientation Data of Pure Aluminum

M. Kobayashi, Y. Takayama, H. Kato and T. Shibayanagi233

Dimensional Effects on Anisotropic Grain Growth

E.A. Holm, G.N. Hassold and M.A. Miodownik239

Simulation of Grain Boundary Migration in Well Topologically Defined Grain Configurations <i>J. Kroc and V. Paidar</i>	245
Modelling Subgrain Growth during Annealing of Deformed Aluminium Alloys <i>S. Abtahi, K. Sjølstad, K. Marthinsen and E. Nes</i>	251
Analytic Model of Grain Growth Based on a Generalized LS Stability Argument and Topological Relationships <i>P. Streitenberger</i>	257
Re-Examination and Extension of Hillert Theory of Two Dimensional Normal Grain Growth <i>G. Liu, H. Yu, X. Song, X. Qin, C. Wang and S. Liu</i>	263
Dynamic Grain Growth in Superplastic AA5083 <i>P. Bate and L. Mackenzie</i>	269
Multi-Phase-Field Model for the Motion of Multiple Interfaces <i>B. Nestler and H. Garcke</i>	275
Simulation of Grain-Growth Using the Multi-Phase Field Method <i>I. Steinbach, M. Apel and P. Schaffnit</i>	283
The Effects of Surface Boundaries and Triple Junctions on Grain Growth in Polycrystalline Films <i>A.L. Giermann, E.A. Holm and A.H. King</i>	291
Experimental Verification of Finite Element Simulation of Curvature-Driven Grain Growth in Al-Foil <i>M.C. Demirel, A.P. Kuprat, D.C. George, B.S. El-Dasher, G.K. Straub and A.D. Rollett</i>	297
Grain Growth in Thin Films with Columnar Microstructure <i>V.Y. Novikov</i>	303
Computer Simulations of Abnormal Subgrain Growth <i>M.A. Miodownik and E.A. Holm</i>	309
Grain Growth and Texture Evolution in Polycrystals with Strong Initial Texture <i>V.Y. Novikov</i>	315
Energy Barriers for the Morphological Evolution and Coarsening of Faceted Crystals <i>G.S. Rohrer and W.W. Mullins</i>	321
Investigation of Two-Dimensional Grain Growth in Al <i>V.G. Sursaeva and S.G. Protasova</i>	327

Analysis of Grain Growth Kinetics Using the Cellular Automaton Method <i>W. Yu, S.P. Banks and E.J. Palmiere</i>	333
---	-----

The Effect of Temperature on Grain Growth in $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ Superconductive Ceramics <i>M.F. Imayev, D.B. Kabirova, H.A. Churbaeva and</i> <i>G.A. Salishchev</i>	339
---	-----

Stagnation Effects in Grain Growth

3D Massively Parallel Cellular Automaton Simulations of Zener Pinning <i>M.A. Miodownik, E.A. Holm and G.N. Hassold</i>	347
--	-----

Effect of Particle Clustering on the Grain Size Control <i>E. Flores, J.M. Cabrera and J.M. Prado</i>	353
--	-----

Modelling of the Interaction of Precipitation and Grain Growth <i>M. Militzer</i>	361
--	-----

Effect of Solute Copper on Grain Growth of Austenite in High Chromium Steels <i>Y. Futamura, T. Tsuchiyama and S. Takaki</i>	367
--	-----

Al-Ti Combination Effect on Austenite Grain Growing Control at Reheating Temperatures <i>S.F. Medina, M. Chapa, V. López and B. Fernández</i>	373
---	-----

Comparison between Pinned and Non-Pinned Initial Grain Growth in a Two-Dimensional Soap Froth <i>C.H. Wörner, A. Olguín, M. Ortiz and O. Herrera</i>	379
--	-----

Simultaneous Nitriding and Decarburization as a Way of Acquiring Grain Growth Inhibition in 3%Si-Fe <i>C.H. Han, J.S. Woo, K.S. Han and S.Y. Cha</i>	383
--	-----

Grain Growth and Intergranular Carbide Precipitation in Nickel-Base Alloy 690 <i>Y.S. Lim, S.S. Hwang, J.H. Suh and J.S. Kim</i>	389
--	-----

On the Effect of Particle Volume Fraction on Grain Growth Inhibition <i>V.Y. Novikov</i>	395
---	-----

Grain Boundary and Triple Junction Properties

Migration of Low Angle Grain Boundaries during Secondary Recrystallisation in Silicon Iron <i>H. Homma and B. Hutchinson</i>	403
--	-----

The Effect of Solute Elements on Grain Boundary Mobility during Recrystallization of Single-Phase Aluminium Alloys <i>Y. Huang and F.J. Humphreys</i>	409
Geometrical Theory of Elements of Polycrystals Consisting of CSL Boundaries <i>V.Y. Gertsman</i>	415
In-Situ Measurement Technique of Grain Boundary and Triple Junction Mobility <i>D. Mattissen, D.A. Molodov, G. Gottstein and L.S. Shvindlerman</i>	421
Capillarity Vector Reconstruction of the Relative Energies of [0001] Tilt Boundaries in Alumina <i>D.M. Saylor, K.W. Cherry and G.S. Rohrer</i>	429
Grain Boundary Properties: Qualitative Analysis of the Relationship "Misorientation-Structure-Energy" <i>V.P. Yashnikov</i>	435
Motion of Grain Boundaries with Triple Junctions in Aluminium <i>D.A. Molodov, G. Gottstein, S.G. Protasova, V.G. Sursaeva and L.S. Shvindlerman</i>	441
Crystallographic Distribution of Grain Boundaries in Magnesium Oxide <i>D.M. Saylor, A. Morawiec, K.W. Cherry, F.H. Rogan, G.S. Rohrer, S. Mahadevan and D. Casasent</i>	449
Mobility of Grain Boundaries and Grain Boundary Systems with Triple Junction: A Direct Comparison <i>V.G. Sursaeva, G. Gottstein and L.S. Shvindlerman</i>	455
Influence of Mechanical Stresses on Twist Grain Boundaries <i>M. Winning, G. Gottstein and L.S. Shvindlerman</i>	463

Steels

Abnormal Grain Growth in Ferritic and Austenitic Stainless Steels due to Second Phase Dissolution <i>F. Siciliano Jr., J.C. Dutra, F.C. Pimenta Jr. and A.F. Padilha</i>	471
A Tribological Study on Strain-Induced Grain Growth <i>M. Takashima, M. Kurosawa and M. Komatsubara</i>	477
Dynamic Observation of Secondary Recrystallization in Cross-Rolled Silicon Steel by Synchrotron X-Ray Topography <i>Y. Ushigami, S. Nakamura, T. Kubota and S. Arai</i>	483

Grain Growth of Iron Oxides during High Temperature Oxidation <i>B.-K. Kim and J.A. Szpunar</i>	489
Microscopic Secondary Recrystallization Process in an Fe-3%Si Alloy <i>S. Takebayashi, S. Suzuki and Y. Ushigami</i>	495

Ultra-Fine Grain Structures

Mechanism of Ultrafine Grain Formation during Equal Channel Angular Extrusion in an Aluminum Alloy at Intermediate Temperature <i>R. Kaibyshev, O. Sitdikov, I. Mazurina and D.R. Lesuer</i>	503
Nanostructures in Al-Based Alloys After Severe Plastic Deformation <i>S.V. Dobatkin, V.V. Zakharov and R.Z. Valiev</i>	509
Dynamically Recrystallized Grain Size of Some Commercial Purity Coppers <i>V.G. García, J.M. Cabrera and J.M. Prado</i>	515
Characteristics of Ultrafine Ferrite Formed by Strain-Induced Dynamic Transformation in Low Carbon Steels <i>J.-K. Choi, K.-K. Um, J.-S. Lee, D.-H. Seo and W.-Y. Choo</i>	521
Grain Growth in Nanocrystalline Ni <i>B.-K. Kim and J.A. Szpunar</i>	525
Grain Growth in Nanocrystalline Ni-20%Fe Alloy <i>Y.B. Park, J. Park, S.S. Kim and T.H. Yim</i>	531
Annealing Behaviour of Ultra Fine-Grained Iron with Dispersed Particles <i>A. Belyakov, Y. Sakai, T. Hara, Y. Kimura and K. Tsuzaki</i>	537
Nano- and Submicrocrystalline Low-Carbon Steels Obtained by Severe Plastic Deformation <i>S.V. Dobatkin, P.D. Odessky, N.A. Krasilnikov, G.I. Raab and V.N. Konenkova</i>	543
The Recrystallization of a Highly Deformed Al-Fe-Mn Alloy <i>H. Jazaeri and F.J. Humphreys</i>	549
Dimensional Effect at the Normal Grain Growth in Nanostructured Aluminium <i>S. Protasova and V. Sursaeva</i>	557
Formation of Micro-, Submicro- and Nanocrystalline Structures in Nickel-Base Alloys <i>V.A. Valitov, O.A. Kaibyshev, Sh.Kh. Mukhtarov and N.R. Gajnutdinova</i>	563

The Formation of Uniform Fine-Grain Microstructures in Two-Phase
Ti-6Al-4V Titanium Alloy during Hot Deformation

*S.V. Zharebtsov, G.A. Salishchev, R.M. Galeev,
O.R. Valiakhmetov, M.F.X. Gigliotti, B.P. Bewlay,
C.U. Hardwicke and R.S. Gilmore*.....569

Advanced Experimental Methods

Application of Laser-Ultrasonics (LUS) to Studies of Recrystallisation
in Metals

E. Lindh-Ulmgren, D. Artymowicz and B. Hutchinson.....577

Monitoring Austenitic Grain Growth Kinetics by Laser-Ultrasonics

S. Kruger, A. Moreau and G. Lamouche583

Growth Kinetics of Individual Cube Grains as Studied by the 3D X-Ray
Diffraction Microscope

*E.M. Lauridsen, S. Schmidt, L. Margulies, H.F. Poulsen
and D. Juul Jensen*.....589

Stereology and 3D Quantitative Characterization of Microstructure for
Grain Growth Studies

G. Liu, C. Wang, S. Liu, X. Qin, H. Yu and X. Song.....595

Substructural Development in Cold Rolled Al-0.13Mg

P.J. Hurley and F.J. Humphreys601

Characterization of Abnormal Contrast Observed in OIM Images
Measured on a Rough Surface

S. Takebayashi, S. Suzuki and Y. Ushigami607

Recrystallized Volume Fraction Analysis

J. Tarasiuk, P. Gerber and B. Bacroix613

Author Index

Keyword Index

VOLUME TWO

Recrystallization

Invited Papers

Relation between Stored Energy and Nucleation Mechanisms <i>B. Bacroix, P. Gerber and O. Castelnau</i>	623
Stored Energies in Plastically Deformed Metals <i>A. Borbély and J.H. Driver</i>	635
Advances in the Study of Recrystallization Kinetics <i>R.A. Vandermeer</i>	645
Recrystallization in Subdivided Deformation Microstructures <i>D.A. Hughes and N. Hansen</i>	659
Dynamic Recrystallization under Continuous and Discontinuous Reaction <i>T. Sakai, A. Belyakov and H. Miura</i>	669
Modelling Recrystallization – Questions of Size and Scale <i>F.J. Humphreys and P.J. Hurley</i>	683
Orientation Selection by Nucleation and Growth in Highly Strained Low Carbon Steels <i>L. Kestens, K. Verbeken and J.J. Jonas</i>	695
Mechanisms of Microstructure and Texture Evolution during Recrystallisation of Ferritic Steels Sheets <i>H. Réglé</i>	707
Recrystallization of Aluminium Alloys <i>E. Nes and H.E. Vatne</i>	719
Recrystallisation and Texture in Industrial Aluminium Sheet <i>J. Hirsch and O. Engler</i>	731
The Numerical Simulation of Microstructures in Geological Materials <i>M. Jessell</i>	741
Experimental Techniques for the Study of Nucleation Processes during Recrystallization <i>S. Zaefferer</i>	751

Mechanisms and Kinetics of Recrystallization

Experimental Investigations of Recrystallization Mechanisms in Copper Alloys

- P. Gerber, J. Tarasiuk, B. Bacroix, T. Chauveau and
R. Chiron*767

Deformation Structure and Recrystallization in an Al Single Crystal Deformed in Tension

- X. Huang, T. Okada, J.A. Wert and F. Inoko*773

Effect of Strain Reversals on Recrystallization Kinetics and Grain Size in Hot-Deformed Austenite

- L.P. Karjalainen and M.C. Somani*779

The Effect of Carbonitride Precipitation on the Recrystallisation Kinetics of Microalloyed Steel during Thermomechanical Processing

- R.M. Poths, R.L. Higginson and E.J. Palmiere*785

Determination of Activation Energy for Static Recrystallization Using Multipass Continuous Cooling Torsion Test

- N. Radović, D. Drobnjak and K. Raić*791

Comparison of Continuous Recrystallization in Aluminum Alloys and Interstitial Free Steel

- H. Jin and S. Saimoto*797

Recrystallization Mechanism of Lath Martensite in High Chromium Steel

- T. Tsuchiyama, Y. Miyamoto and S. Takaki*.....803

Investigation of Relationships between Matrix Orientations and Nuclei at Triple Junctions

- T.J. Sabin, G. Winther and D. Juul Jensen*809

Measurement of Dislocation Densities in the Subgrain Interiors

- T. Pettersen and A. Bardal*815

Recovery and Recrystallisation Kinetics in Deformed AA1050 after Simulated Break Down Rolling

- S.P. Chen, T. Zuidwijk and S. van der Zwaag*821

Study of the Static Recrystallisation of an Fe-%30Ni Alloy and Comparison with Plain Carbon Steels

- S. Almaguer, C.M. Sellars and W.M. Rainforth*.....831