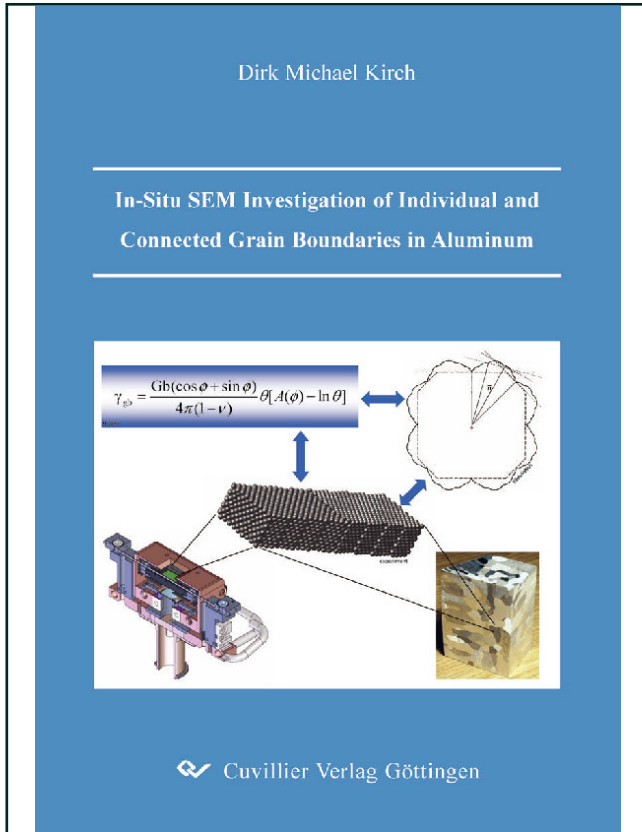




Dirk Michael Kirch (Autor)
**In-Situ SEM Investigation of Individual and
Connected Grain Boundaries in Aluminum**



<https://cuvillier.de/de/shop/publications/1482>

Copyright:
Cuvillier Verlag, Inhaberin Annette Jentsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen,
Germany
Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

Contents

| | |
|--|-----------|
| Preface | i |
| 1 Fundamentals of grain boundaries and triple junctions | 1 |
| 1.1 Grain boundaries | 1 |
| 1.1.1 Terminology | 1 |
| 1.1.2 Atomic structure of grain boundaries | 6 |
| 1.1.3 Kinetics of grain boundaries | 12 |
| 1.2 Grain boundary systems with triple junction | 23 |
| 1.2.1 Terminology | 23 |
| 1.2.2 Atomic structure of triple junctions | 24 |
| 1.2.3 Kinetics of triple junctions | 27 |
| 1.3 Grain growth - Impact of grain boundary and triple junction kinetics | 32 |
| 1.3.1 Von Neumann-Mullins relation | 32 |
| 1.3.2 Effect of triple junction drag on the Von Neumann- Mullins relation | 32 |
| 2 Experimental setup | 35 |
| 2.1 Methods of investigation | 35 |
| 2.1.1 Discontinuous Method | 36 |
| 2.1.2 Continuous Method | 36 |
| 2.2 Laser-powered heating facility | 39 |
| 2.2.1 Previous in-situ heating facilities | 39 |
| 2.2.2 Fundamental new approach | 41 |
| 2.2.3 Construction of a laser-powered heating facility | 42 |
| 2.2.4 Potential area of application | 47 |
| 2.3 Experimental procedure | 52 |

| | | |
|----------|--|------------|
| 2.3.1 | Bi- and tricrystal fabrication | 52 |
| 2.3.2 | Experimental investigation and evaluation | 54 |
| 3 | Kinetics of connected grain boundaries | 59 |
| 3.1 | Kinetics of connected $\langle 100 \rangle$ tilt grain boundaries | 60 |
| 3.1.1 | Experimental results | 60 |
| 3.1.2 | Discussion | 70 |
| 3.1.3 | Summary | 75 |
| 3.2 | Impact of a twist component on $\langle 111 \rangle$ tilt boundaries | 79 |
| 3.2.1 | Experimental Results | 79 |
| 3.2.2 | Discussion | 86 |
| 3.2.3 | Summary | 89 |
| 4 | Faceting and kinetic behavior of SAGBs | 91 |
| 4.1 | GB anisotropy - fundamentals and previous studies | 91 |
| 4.1.1 | Dependency of the grain boundary free energy on boundary inclination - the Wulff-plot | 95 |
| 4.1.2 | Roughening Transition | 98 |
| 4.2 | Experimental results on $\langle 100 \rangle$ tilt grain boundaries | 102 |
| 4.3 | Wulff-plot of $\langle 100 \rangle$ tilt grain boundaries - an MS-study | 112 |
| 4.3.1 | Simulation method at zero Kelvin | 113 |
| 4.3.2 | Computation of grain boundary free energy at ele- vated temperatures | 117 |
| 4.3.3 | Simulation results - $\langle 100 \rangle$ tilt grain boundaries | 118 |
| 4.4 | Discussion | 123 |
| 4.5 | Experimental results on $\langle 111 \rangle$ tilt grain boundaries | 128 |
| 4.6 | MS-study on $\langle 111 \rangle$ tilt grain boundaries | 138 |
| 4.7 | Discussion | 144 |
| 4.8 | Summary | 147 |
| 4.9 | Microstructure evolution - 2D-vertex model | 149 |
| 4.9.1 | Results - 2D-vertex model | 151 |
| 4.9.2 | Discussion | 160 |
| 4.10 | Summary | 161 |
| 5 | Summary and Outlook | 163 |
| | Bibliography | 169 |
| | Appendix | 179 |