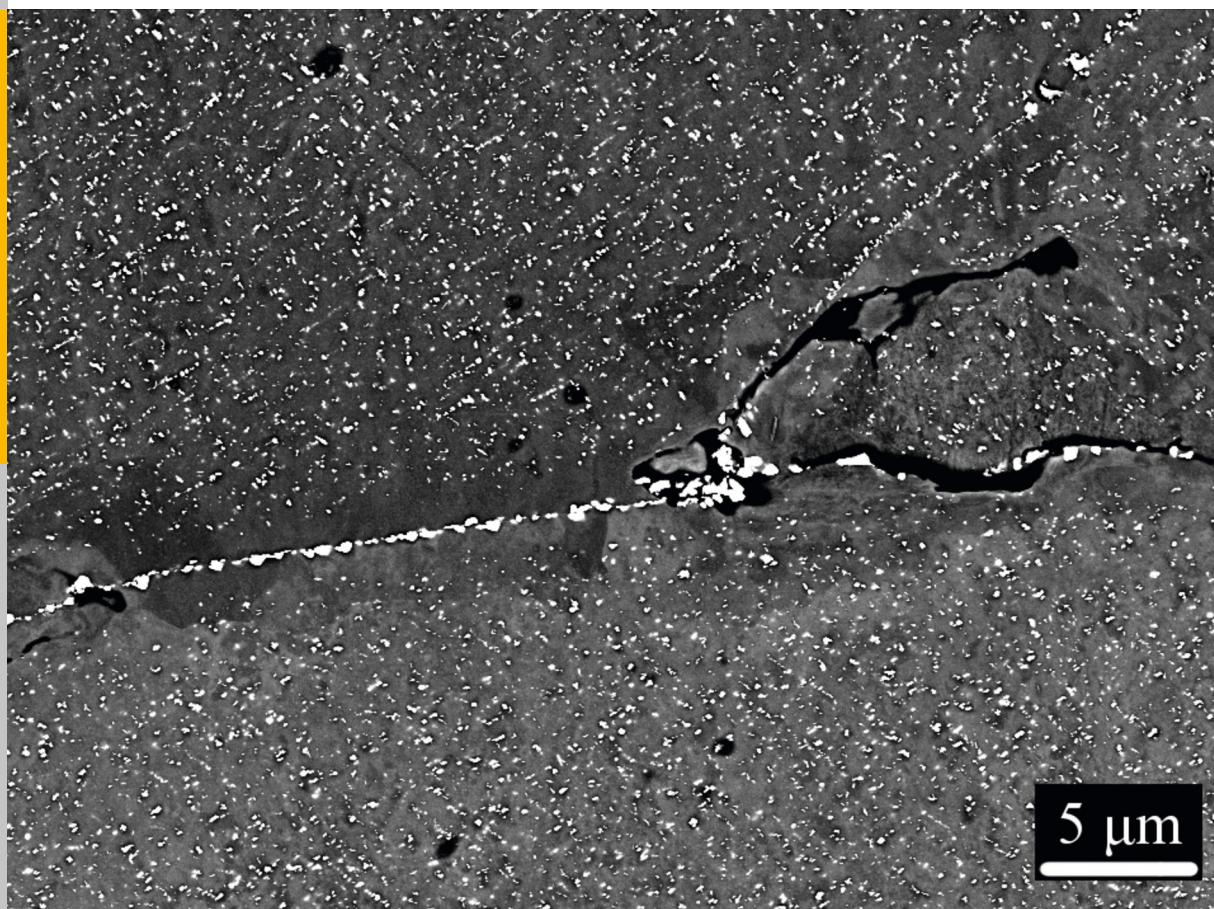


Influence of Initial Thermomechanical Treatment on High Temperature Properties of Laves Phase Strengthened Ferritic Steels

Michal Talík



Forschungszentrum Jülich GmbH
Institute of Energy and Climate Research (IEK)
Microstructure and Properties of Materials (IEK-2)

Influence of Initial Thermomechanical Treatment on High Temperature Properties of Laves Phase Strengthened Ferritic Steels

Michal Talík

Schriften des Forschungszentrums Jülich
Reihe Energie & Umwelt / Energy & Environment

Band / Volume 338

ISSN 1866-1793

ISBN 978-3-95806-175-0

Contents

Abstract	xvii
Überblick	xix
Acknowledgements	xxiii
1 Introduction	1
1.1 Requirements for modern steels used in power industry	1
1.2 Objective	3
1.3 Outline	4
2 Literature review	5
2.1 Transformation in solid-state metals	5
2.1.1 Recrystallization and coarsening	5
2.1.2 Solid State Precipitation	7
2.1.3 Precipitate Coarsening	14
2.2 Creep	19
2.2.1 Strengthening mechanisms of creep resistant steels	24
2.2.2 Development of dislocation structures in particle strengthened materials .	28
2.2.3 Coarsening of subgrains	31
2.2.4 Influence of precipitation on creep	31
2.2.5 Creep modeling	34
2.3 Creep testing	38
2.3.1 Uniaxial creep testing	38
3 Experimental methods	41
3.1 Material	41
3.2 Annealing experiments	42
3.3 Metallography analysis	42
3.3.1 Optical microscopy	42
3.3.2 Scanning electron microscopy	42

3.3.3	Image analysis	43
3.4	Mechanical testing	43
3.4.1	Tensile testing	43
3.4.2	Tensile creep experiments	43
4	Results	45
4.1	Alloy design	45
4.1.1	Influence of W, Nb, and Si on microstructure	45
4.1.2	Design of the experimental steels	49
4.2	Initial microstructure and properties	51
4.3	Recrystallization annealing	54
4.4	Influence of thermo-mechanical treatment on precipitation behaviour	56
4.4.1	Microstructure development during isothermal annealing of samples starting from the as rolled state	56
4.4.2	Microstructure development during isothermal annealing starting from the recrystallized state	62
4.4.3	Influence of low temperature tempering on microstructural development at 650 °C	65
4.4.4	The influence of high temperature tempering on microstructural development at 650 °C	67
4.5	Creep properties of 17Cr1 HiperFer steel in different thermo-mechanical treatment states	74
4.5.1	Rolled 17Cr1	74
4.5.2	Thermally treated 17Cr1	83
4.6	Modeling	91
4.6.1	Creep curve modeling	93
4.6.2	Growth of particles modeling	94
5	Discussion	105
5.1	Creep properties	105
5.1.1	Creep properties of rolled 17Cr1 steel	105
5.1.2	Influence of tempering on the creep strength of 17Cr1 steel	107
5.1.3	The role of grain boundary precipitation on the creep properties of 17Cr1 steel	112
5.1.4	Overview of creep properties	115
5.2	Modeling of particle size evolution	119
6	Conclusions and outlook	123

**Energie & Umwelt /
Energy & Environment
Band / Volume 338
ISBN 978-3-95806-175-0**

