Strip casting of stainless steels

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D. Raabe: Acta Materialia 45 (1997) 1137–1151

INTRODUCTION

FLAT PRODUCTS OF STAINLESS STEELS ARE CONVENTIONALLY MANUFACTURED BY CONTINUOUS CASTING, HOT ROLLING, HOT BAND ANNEALING, PICKLING, COLD ROLLING AND RECRYSTALLISATION.

IN THE LAST YEARS STRIP CASTING HAS INCREASINGLY ATTRACTED ATTENTION.

IT OFFERS THREE IMPROVEMENTS IN COMPARISON TO THE CONVENTIONAL METHOD.

1.) IT ALLOWS TO CAST STEEL SHEETS WITH THE SAME THICKNESS AND WIDTH AS THOSE PRODUCED BY HOT ROLLING. THIS MEANS THAT THE HOT ROLLING PROCESS IS BYPASSED.

2.) THE STRIP CAST STEEL REVEALS A WEAK INITIAL TEXTURE AND A NEGLIGIBLE THROUGH-THICKNESS TEXTURE GRADIENT. THESE FEATURES ARE BENEFICIAL FOR THE STRENGTH AND THE DEEP DRAWING PROPERTIES OF THE FINAL SHEET. THE LATTER ASPECT IS OF SPECIAL RELEVANCE FOR THE AVOIDANCE OF THE SO CALLED RIDGING PHENOMENON IN FERRITIC STAINLESS STEELS [2,3]. THIS EFFECT DETERIORATES THE SURFACE QUALITY OF CONVENTIONAL SHEETS.

3.) IT IS ECONOMICALLY NOT FAVOURABLE TO PRODUCE SMALL AMOUNTS OF HIGHLY ALLOYED STAINLESS STEELS BY CONTINUOUS CASTING AND HOT ROLLING.

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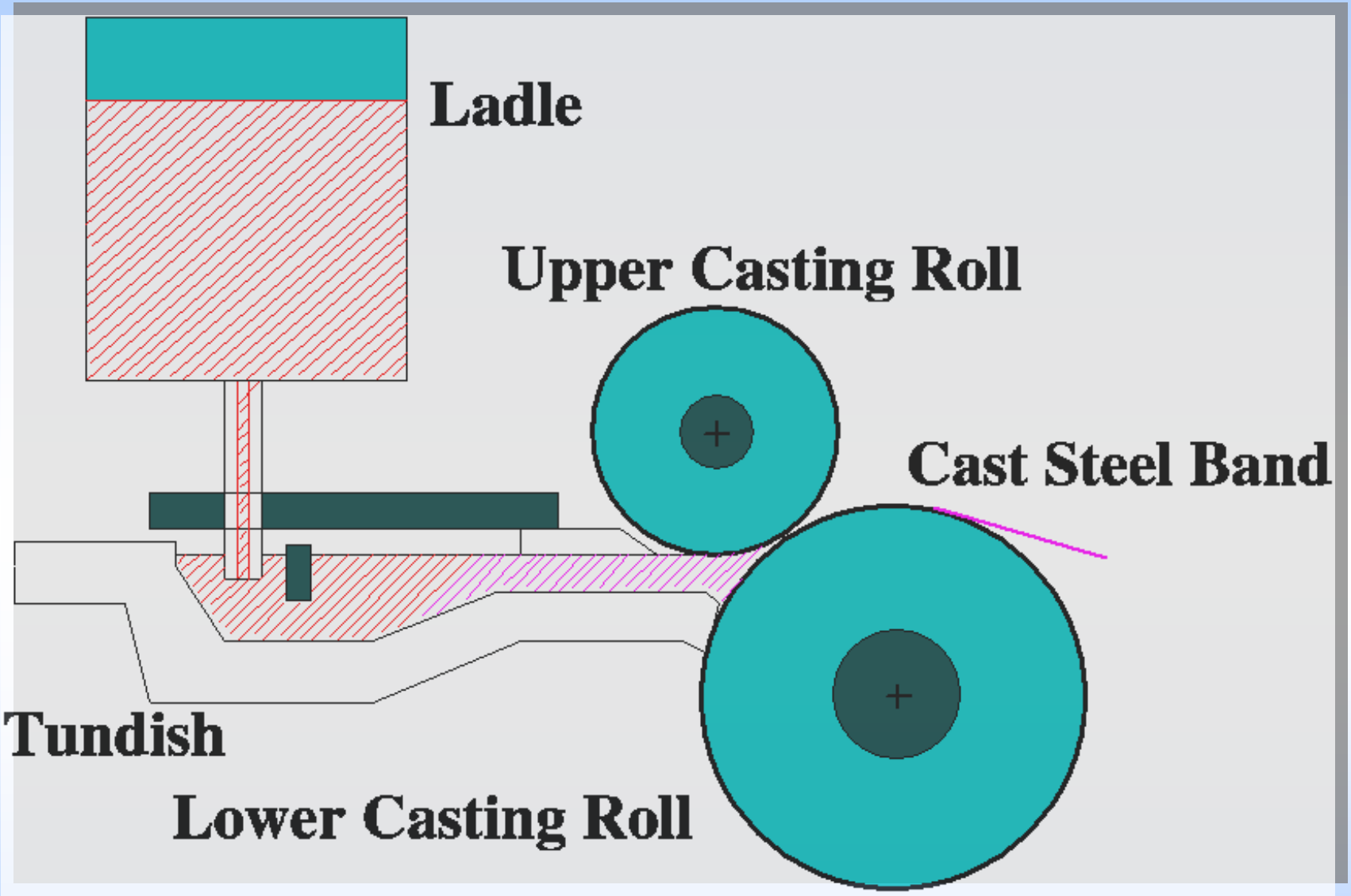
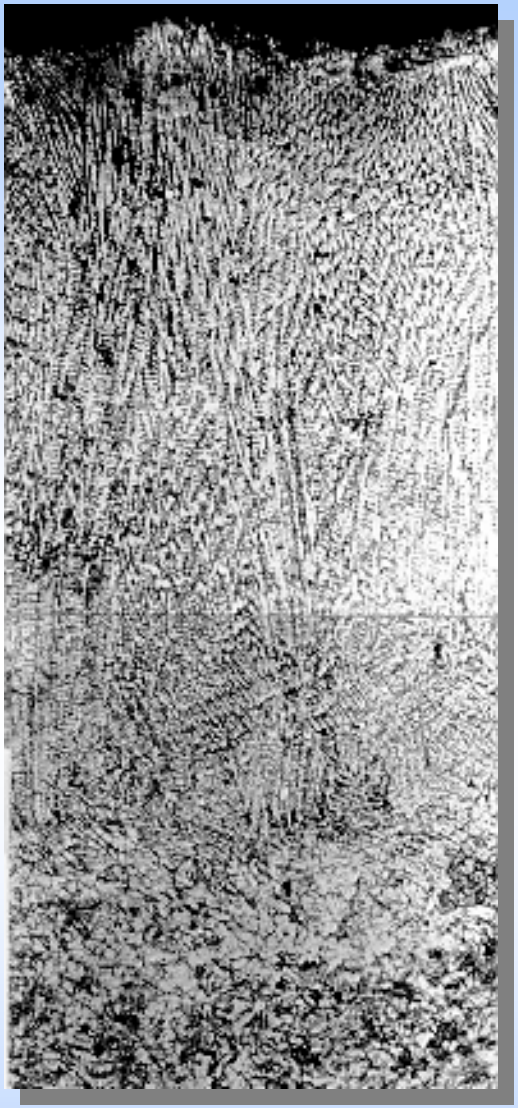
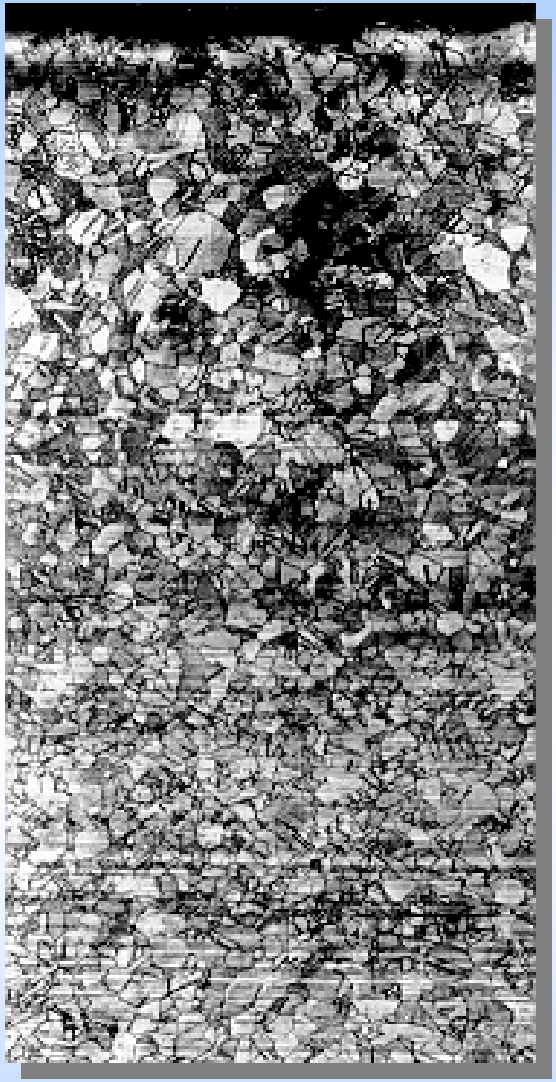

Ladle
Upper Casting Roll
Cast Steel Band
Tundish
Lower Casting Roll

Set up



strip cast



hot rolled

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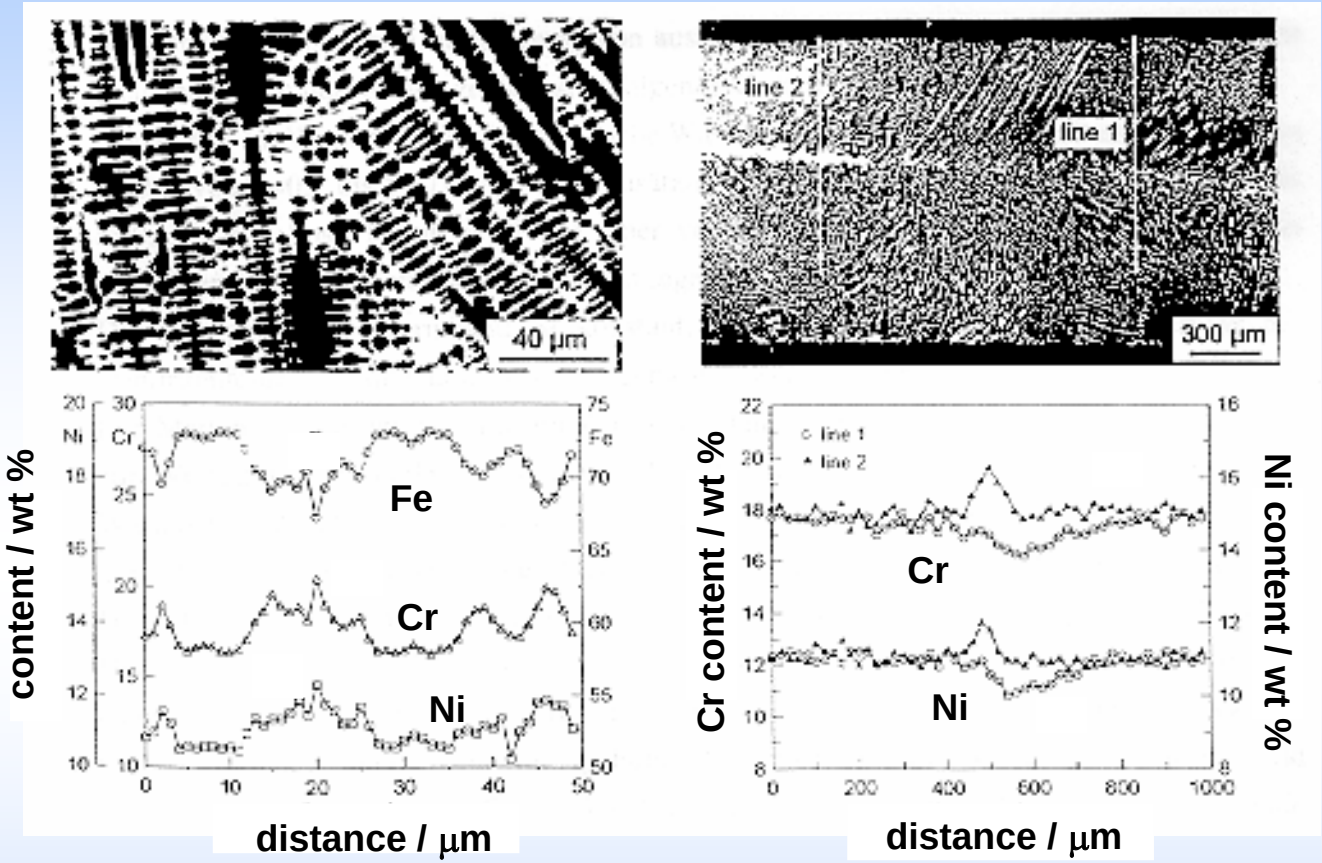
Stainless steel

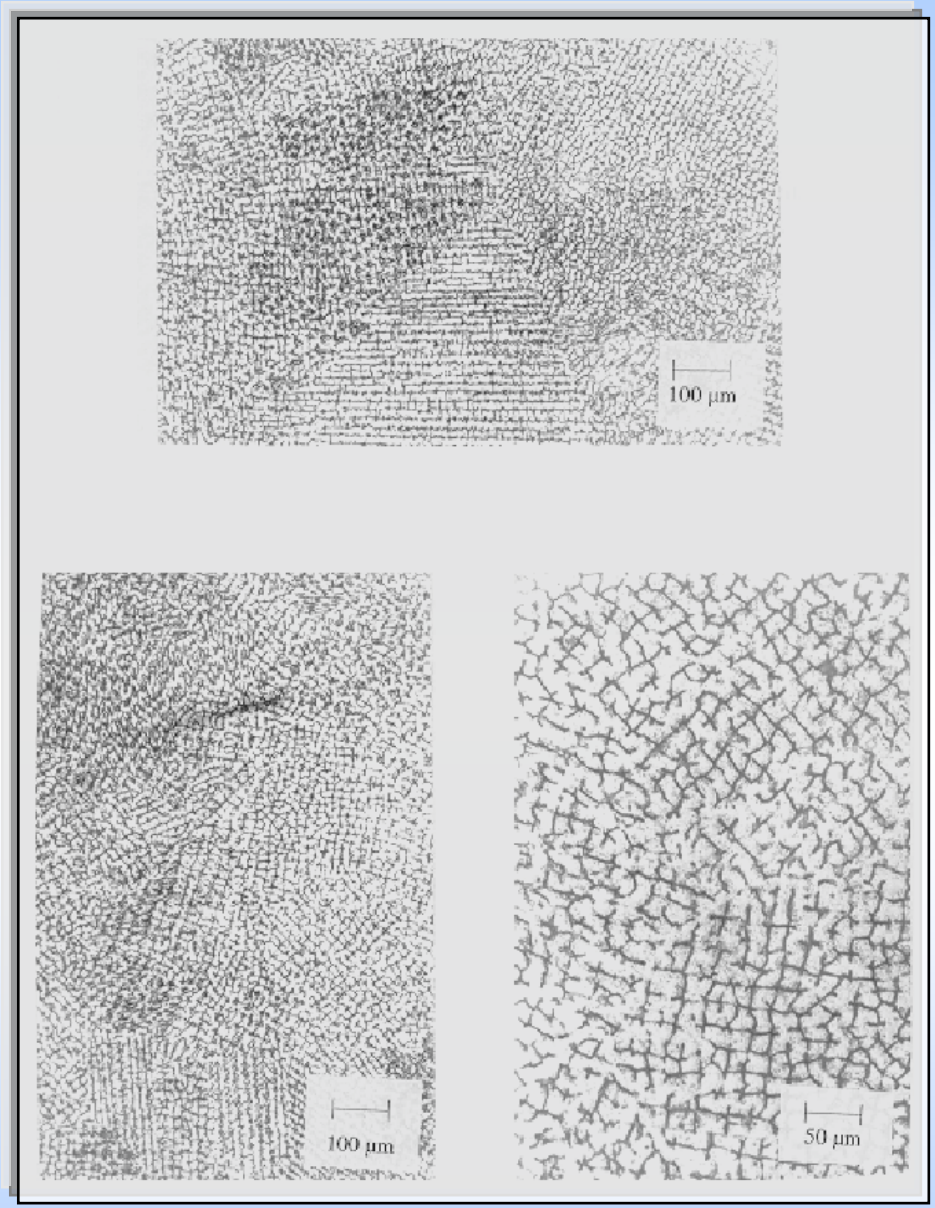
microstructure, austenite



microsegregation

macrosegregation

segregation, strip cast austenite



surface, flat section

s=0.5, flat section

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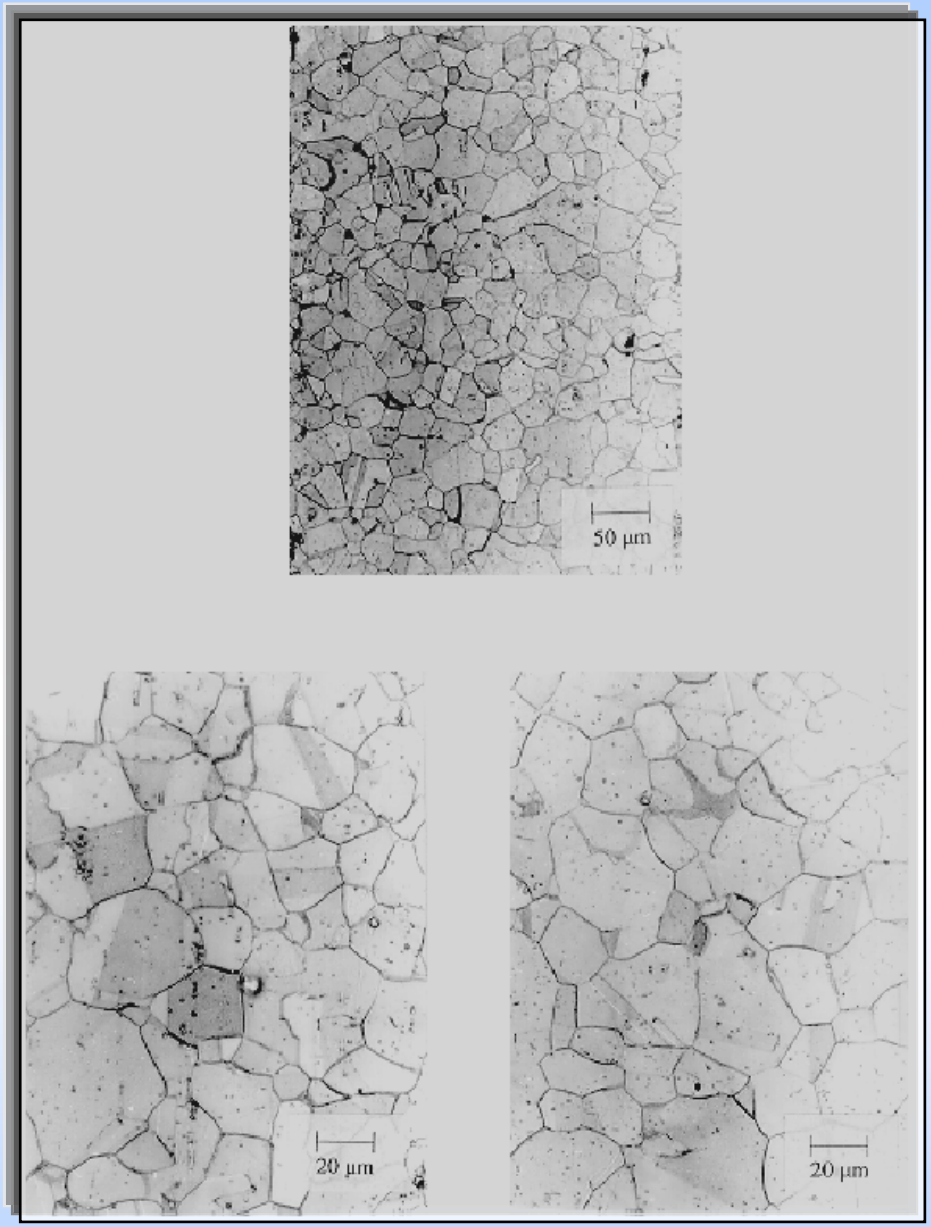
Stainless steel

flat sections, strip cast austenite

surface, flat section



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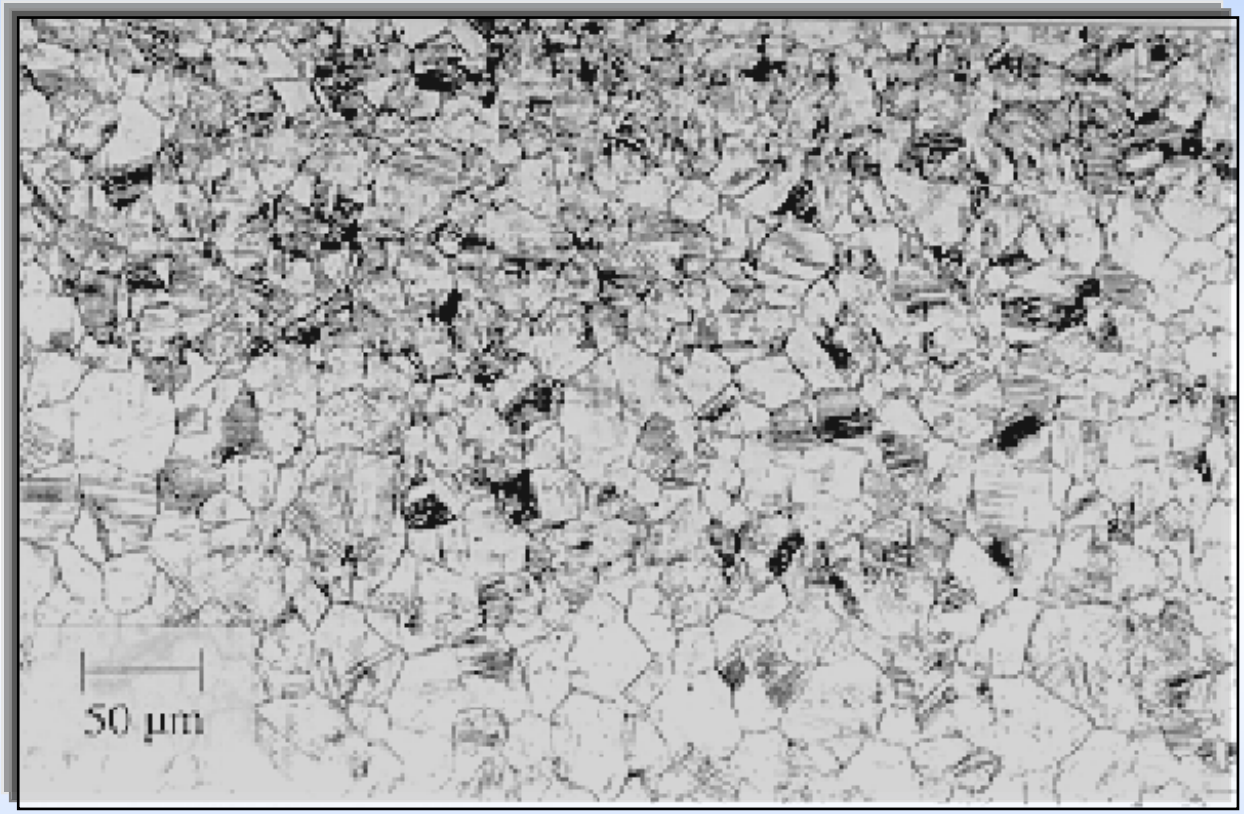
Stainless steel

flat sections, hot rolled austenite

s=0.5, flat section



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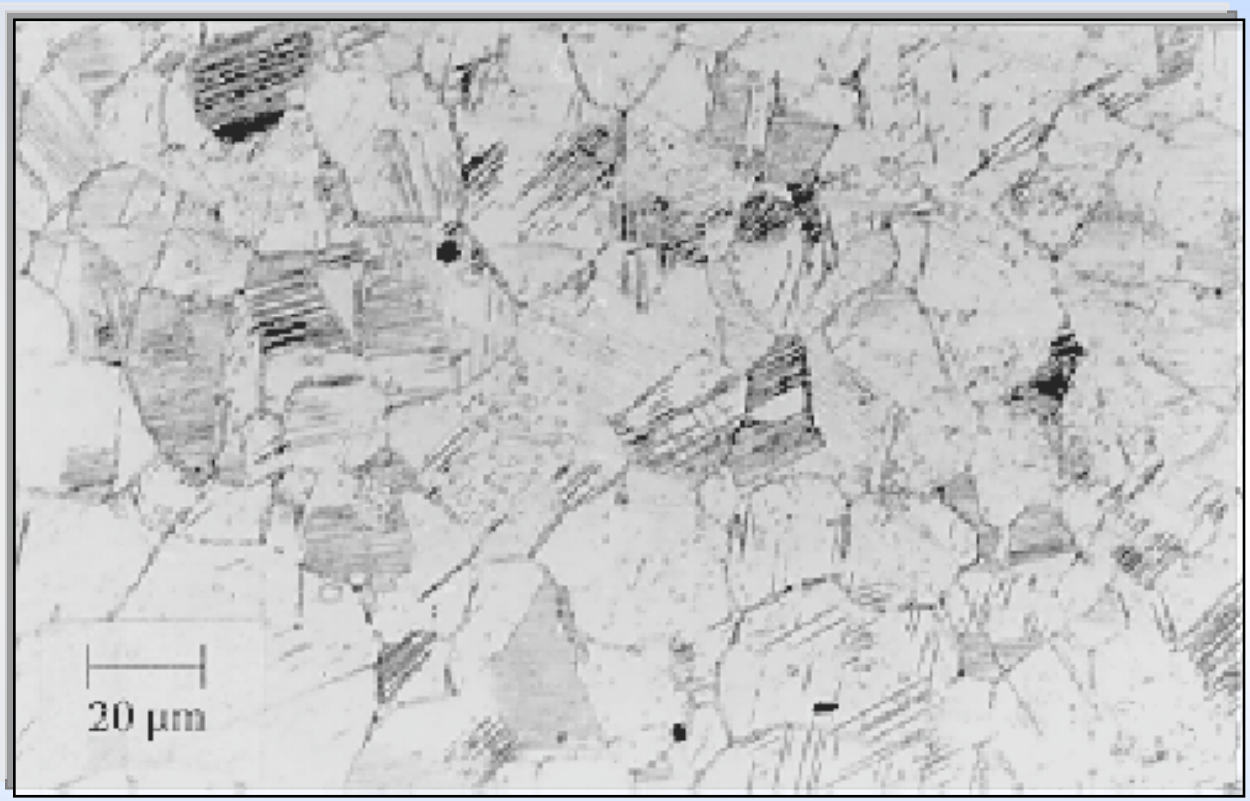
flat sections, hot rolled austenite

s=0.5, flat section



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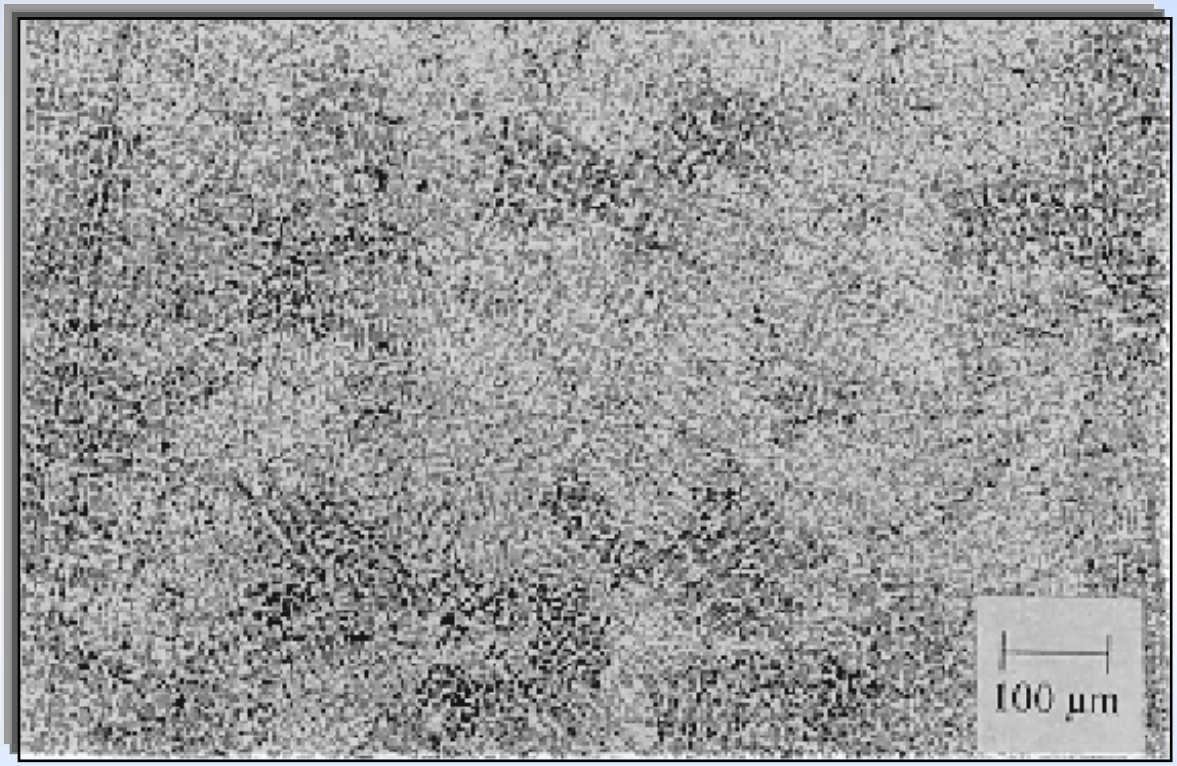
flat sections, hot rolled austenite

s=0.5, flat section



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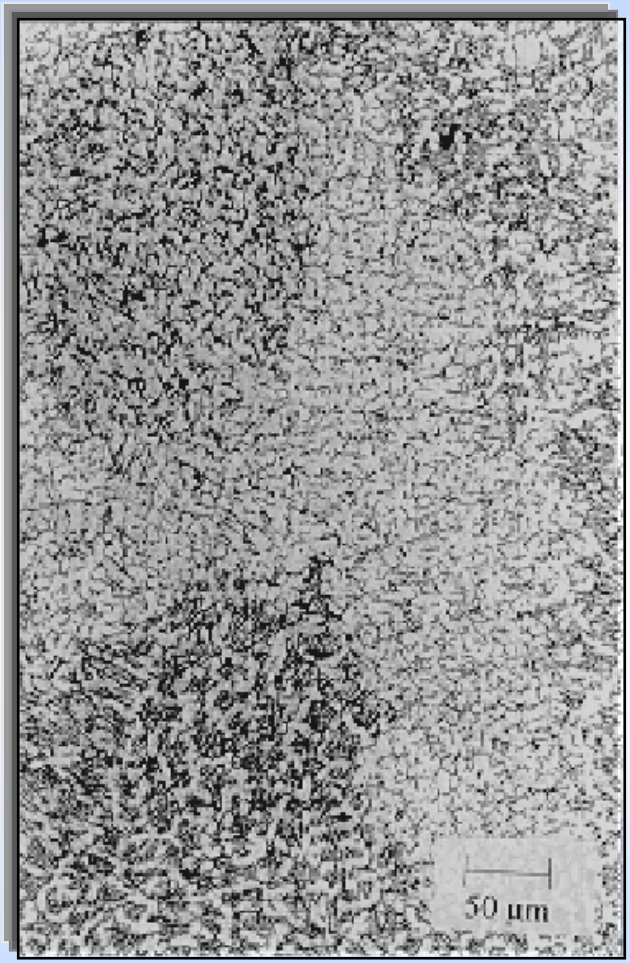
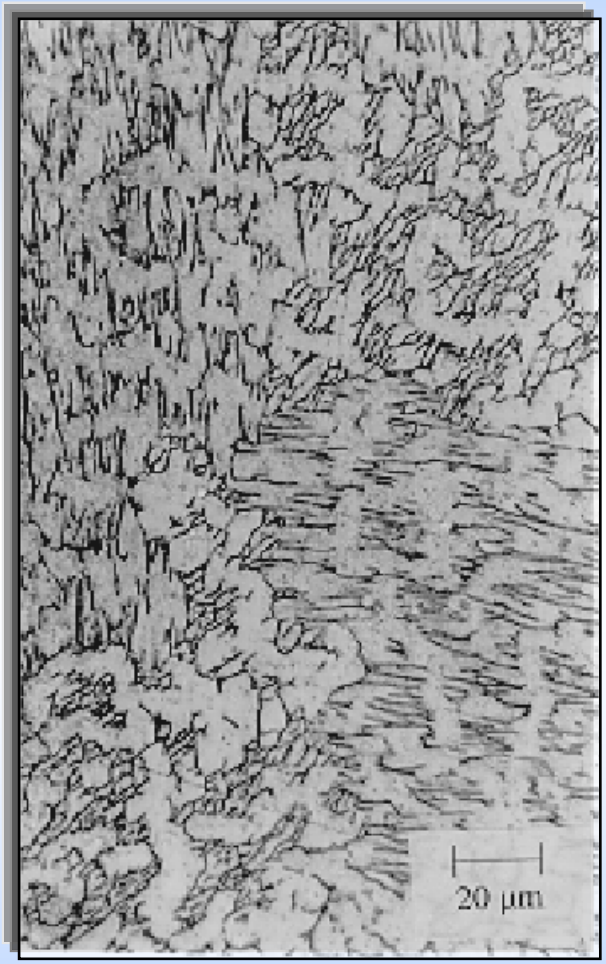
flat sections, strip cast austenite

s=0.5, flat section





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flat sections, strip cast austenite

s=center layer, flat section

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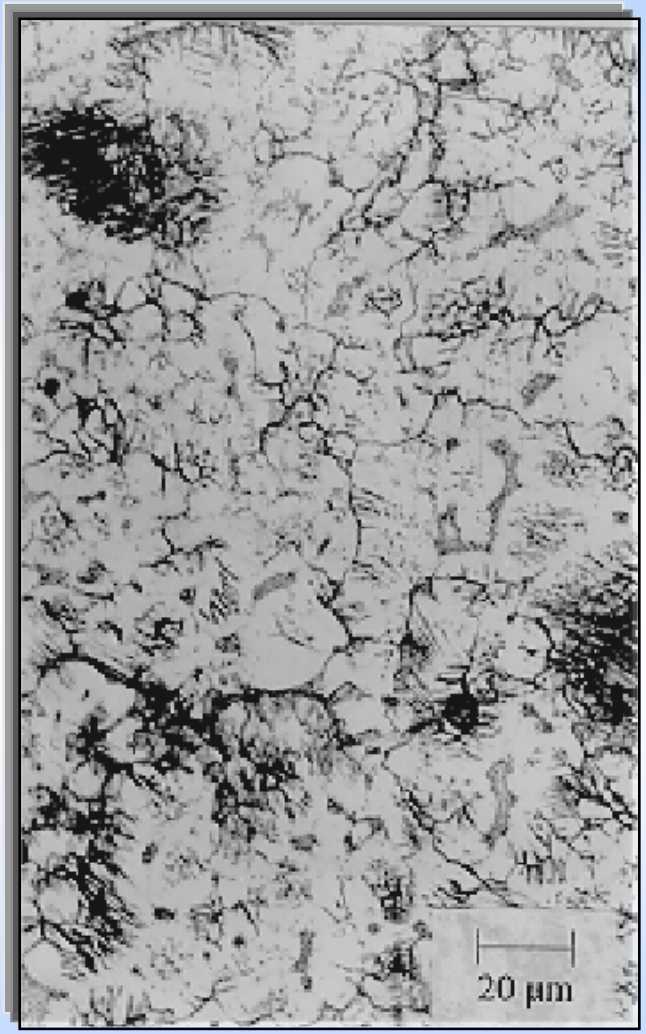
flat sections, strip cast austenite

s=center layer, flat section



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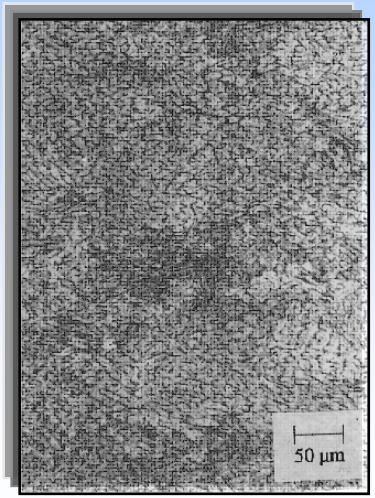
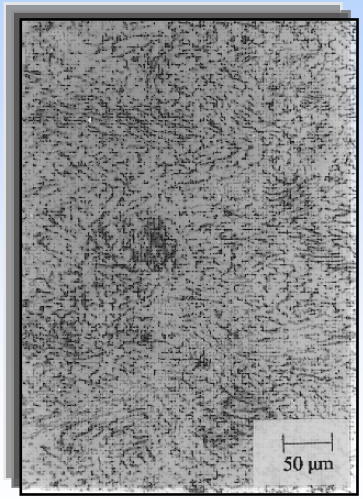
flat sections, strip cast austenite

longitudinal section

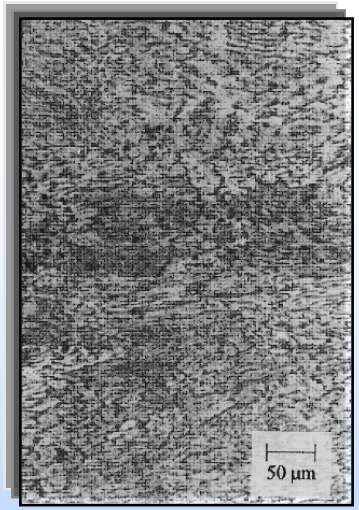
ε=50%





ε=60%

ε=70%



ε=80%

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austenite, strip cast, cold rolled

chemical composition of the austenitic stainless steel in mass %

C	Si	Mn	Cr	Mo	Ni	Fe
0.05	0.76	1.37	18.10	0.24	8.54	balance

martensite in the cold rolled hot band sample

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austenite, strip cast, cold rolled

ε=80%,
30 min,
850°C

flat section

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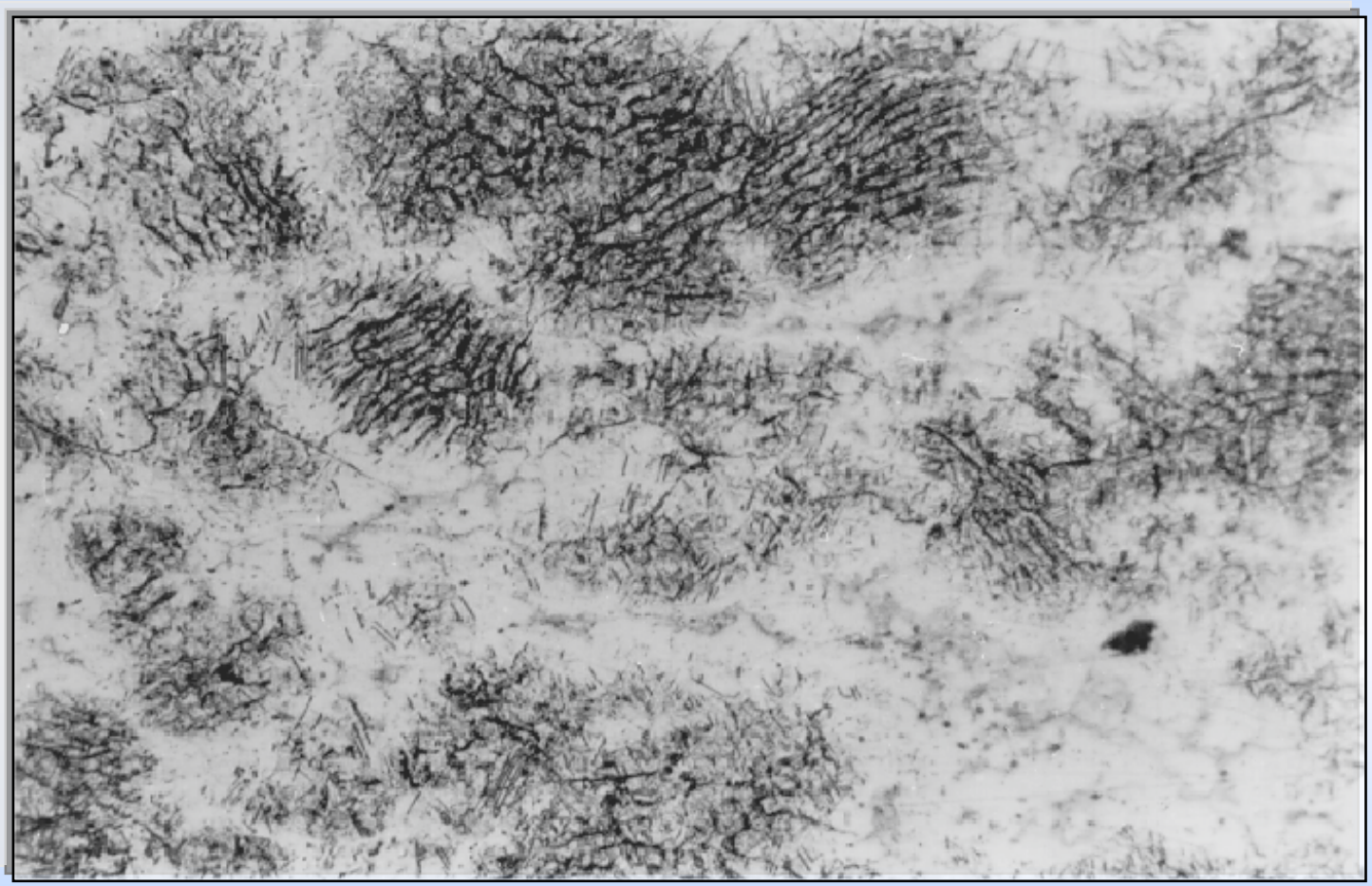
strip cast, cold rolled + annealed austenite

flat section

ε=80%,
30 min,
850°C



D. Raabe: Acta Materialia 45 (1997) 1137–1151

strip cast, cold rolled + annealed austenite

D. Raabe, K. Lücke: Scripta Metall. 26 (1992) 1221–1226
„Texture and microstructure of hot rolled steel“

M. Hölscher, D. Raabe, K. Lücke: Steel Research 62 (1991) 567–575
„Rolling and recrystallization textures of bcc steels“

D. Raabe, K. Lücke: Scripta Metall. 26 (1992) 19–24
„Selective particle drag during primary recrystallization of Fe-Cr alloys“

D. Raabe, K. Lücke: Scripta Metall. 27 (1992) 1533–1538
„Annealing textures of bcc metals“

D. Raabe, K. Lücke: Steel Research 63 (1992) 457–464
„Influence of particles on recrystallization textures of ferritic stainless steels“

D. Raabe, M. Hölscher, F. Reher, K. Lücke: Scripta Metall. 29 (1993) 113–116
„Textures of strip cast Fe-16% Cr“

D. Raabe, M. Hölscher, M. Dubke, H. Pfeifer, H. Hanke, K. Lücke: Steel Research 4 (1993) 359–363
„Texture development of strip cast ferritic stainless steels“

References 01

D. Raabe, K. Lücke: Materials Science and Technology 9 (1993) 302–312
„Textures of ferritic stainless steels“

M. Hölscher, D. Raabe, K. Lücke: Acta metall. 42 (1994) 879–886
„Relationship between rolling textures and shear textures in f.c.c. and b.c.c. metals“

D. Raabe: Journal of Materials Science 30 (1995) 47–52
„Inhomogeneity of the crystallographic texture in a hot rolled austenitic stainless steel“

D. Raabe: Metallurgical and Materials Transactions A 26A April (1995) 991–998
„Microstructure and crystallographic texture of strip cast and hot rolled austenitic stainless steel“

D. Raabe: Materials Science and Technology 11 (1995) 461–468
„Textures of strip cast and hot rolled ferritic and austenitic stainless steel“

D. Raabe: Materials Science and Technology 11 (1995) 985–993
„Experimental investigation and simulation of rolling textures of Fe-11wt.% Cr“

References 02

D. Raabe, M. Ylitalo: Metallurgical and Materials Transactions A, 27 (1996) 49–57
„Experimental investigation of the transformation texture in hot rolled ferritic stainless steel using single orientation determination“

D. Raabe: Acta Materialia 45 (1997) 1137–1151
„Texture and microstructure evolution during cold rolling of a strip cast and of a hot rolled austenitic stainless steel“

References 03