Worldwide Activity

www.msm.cam.ac.uk/phase-trans

A. A. Howe, *Materials Science and Technology* **16** (2000) 1264-1266

P. M. Brown, D. P. Baxter, *Materials Science and Technology* 2004

F. G. Caballero & Bhadeshia, *Current Opinion* **8** (2004) 251-257

Bhadeshia, *Materials Science & Technology* **21** (2005) 1293-1302

C. Garcia-Mateo *et al*., *Rev. Metal. Madrid* **41** (2005) 186-193

Mateo and Caballero, *ISIJ International* **45** (2005) 1736-1740

Mateo and Caballero, *Int. J. of Mat. Research* **98** (2007) 137-143

Caballero *et al*., *Mat. & Manufacturing Proc.* **22** (2007) 502-506

A. A. Howe, *Materials Science and Technology* **15** (2009) 815-819

Bhadeshia, *Proc. Royal Society A* **466** (2010) 3-18

UNIVERSITY OF CAMBRIDGE

Make samples which are large in all dimensions.

Commercial steels available where distance between interfaces is 250-100 nm. Here the distance must be an order of magnitude smaller.

Affordable

Crystallography of carbide-free bainite in a hard bainitic steel

F. C. Zhang and P. M. Kelly
Materials Science and Engineering **A438-440** (2006) 272-275

$$(1\,1\,1)_\gamma\ 0.7 \pm 0.5^\circ\ \text{from}\ (1\,0\,1)_\alpha$$
$$[\bar{1}\,0\,1]_\gamma\ 2.5 \pm 1.5^\circ\ \text{from}\ [\bar{1}\,1\,1]_\alpha$$

Important in understanding how stress affect transformation

Habit plane $\mathbf{p}_\gamma$

$$\begin{pmatrix} -0.168640 \\ -0.760394 \\ -0.627185 \end{pmatrix}$$

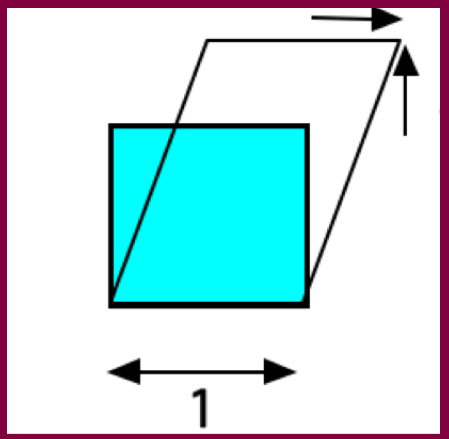
Orientation (γ J α)

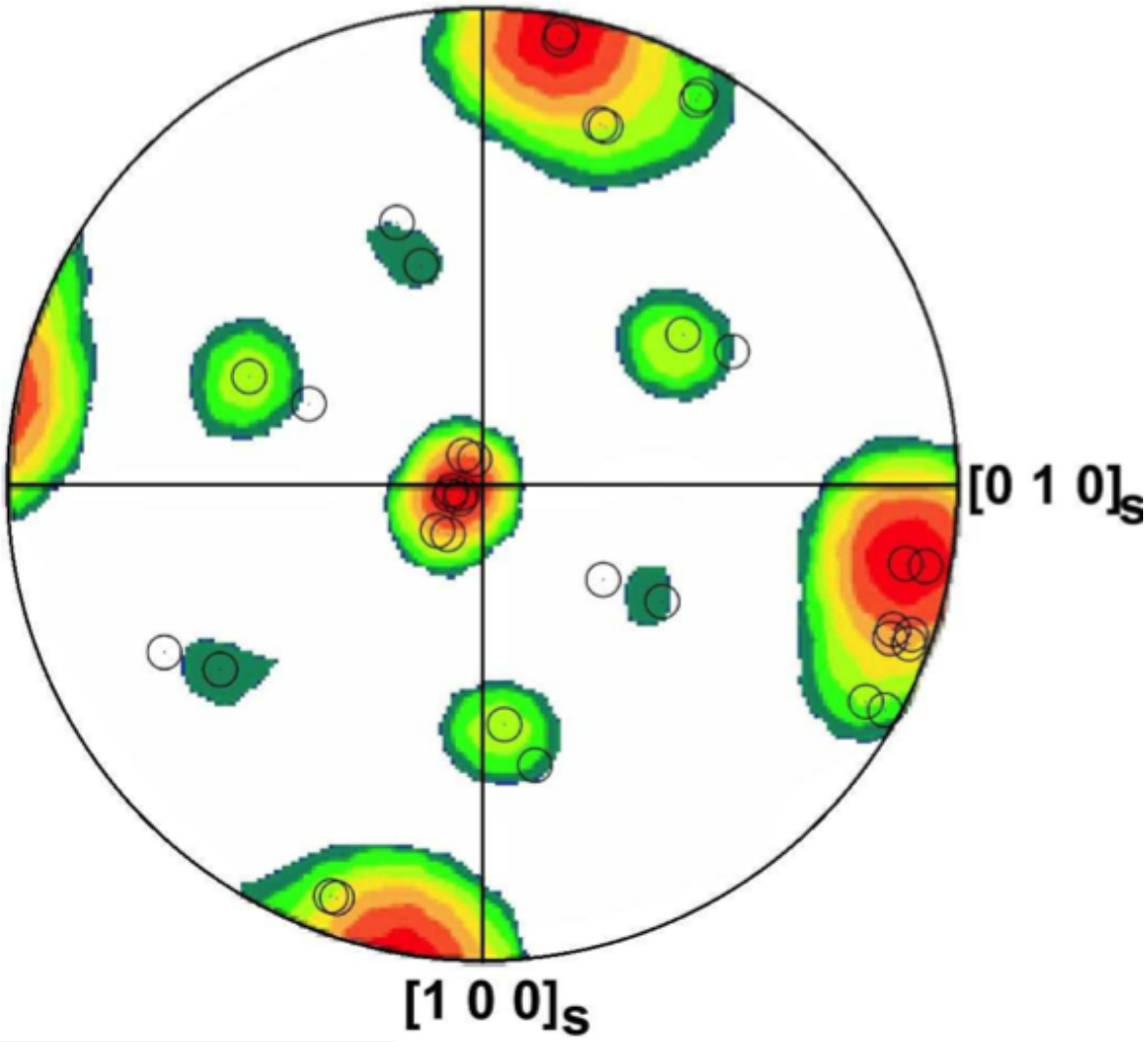
$$\begin{pmatrix} 0.575191 & 0.542067 & 0.097283 \\ -0.550660 & 0.568276 & 0.089338 \\ -0.008610 & -0.131800 & 0.785302 \end{pmatrix}$$

$$[\bar{1}\ 0\ 1]_\gamma || [-0.920611\ -1.062637\ 1.084959]_{\alpha'}$$
$$(1\ 1\ 1)_\gamma || (0.015921\ 0.978543\ 0.971923)_{\alpha'}$$

Shape change (γ P γ)

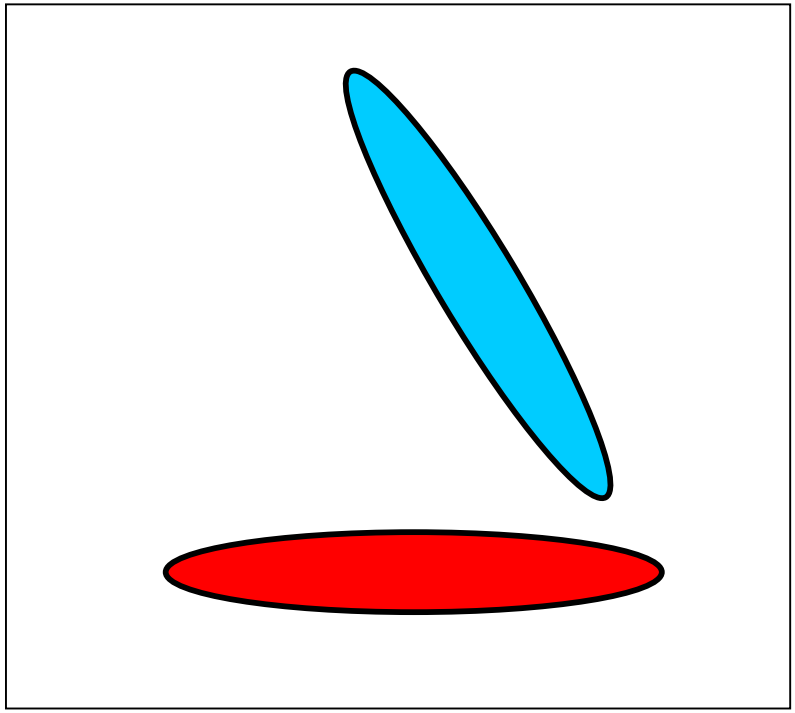
$$\begin{pmatrix} 0.992654 & -0.033124 & -0.027321 \\ 0.026378 & 1.118936 & 0.098100 \\ -0.027321 & -0.123190 & 0.898391 \end{pmatrix}$$

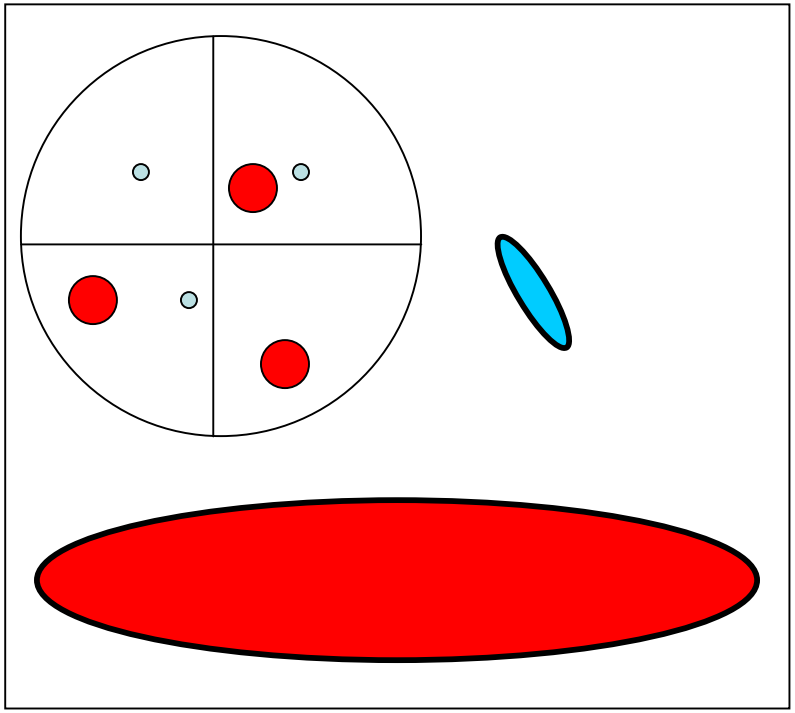


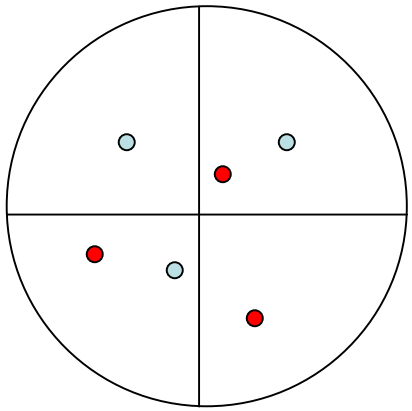


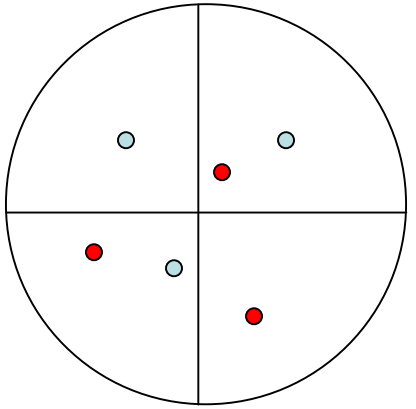
S. Kundu, K. Hase and H. K. D. H. Bhadeshia
Proc. of The Royal Society A, **463** (2007) 2309-2328

No method calculates INTENSITY,
only POSITIONS of poles

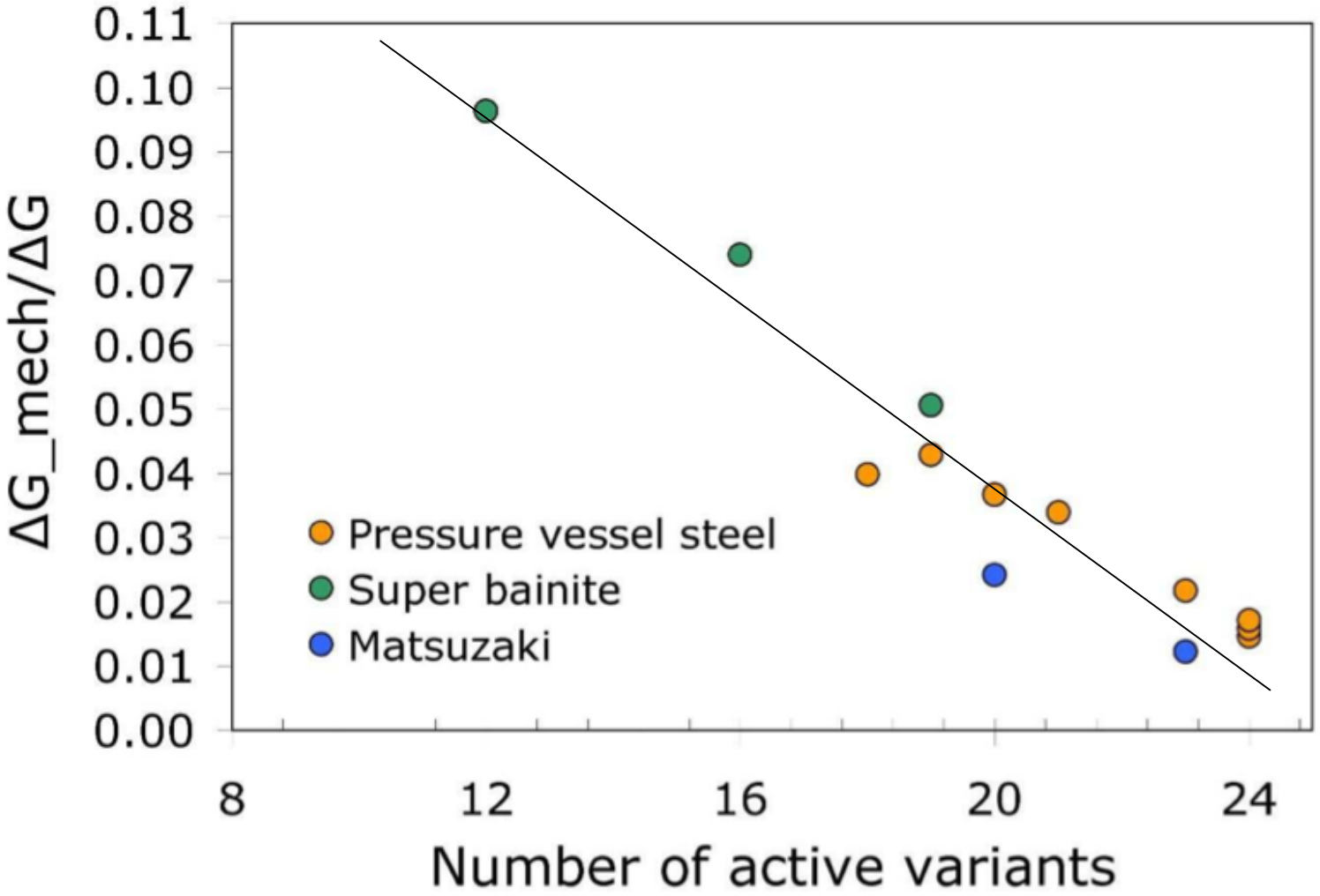


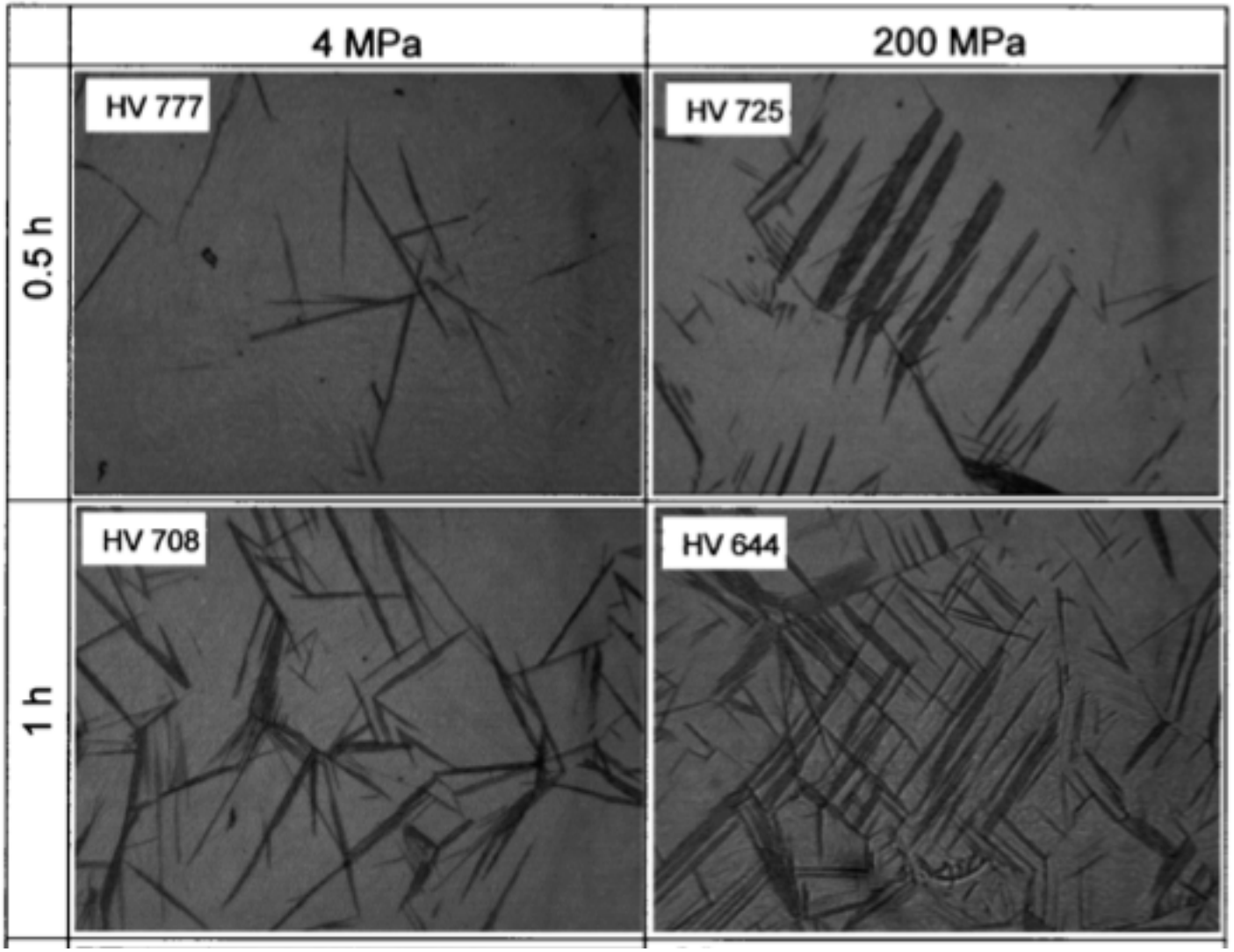




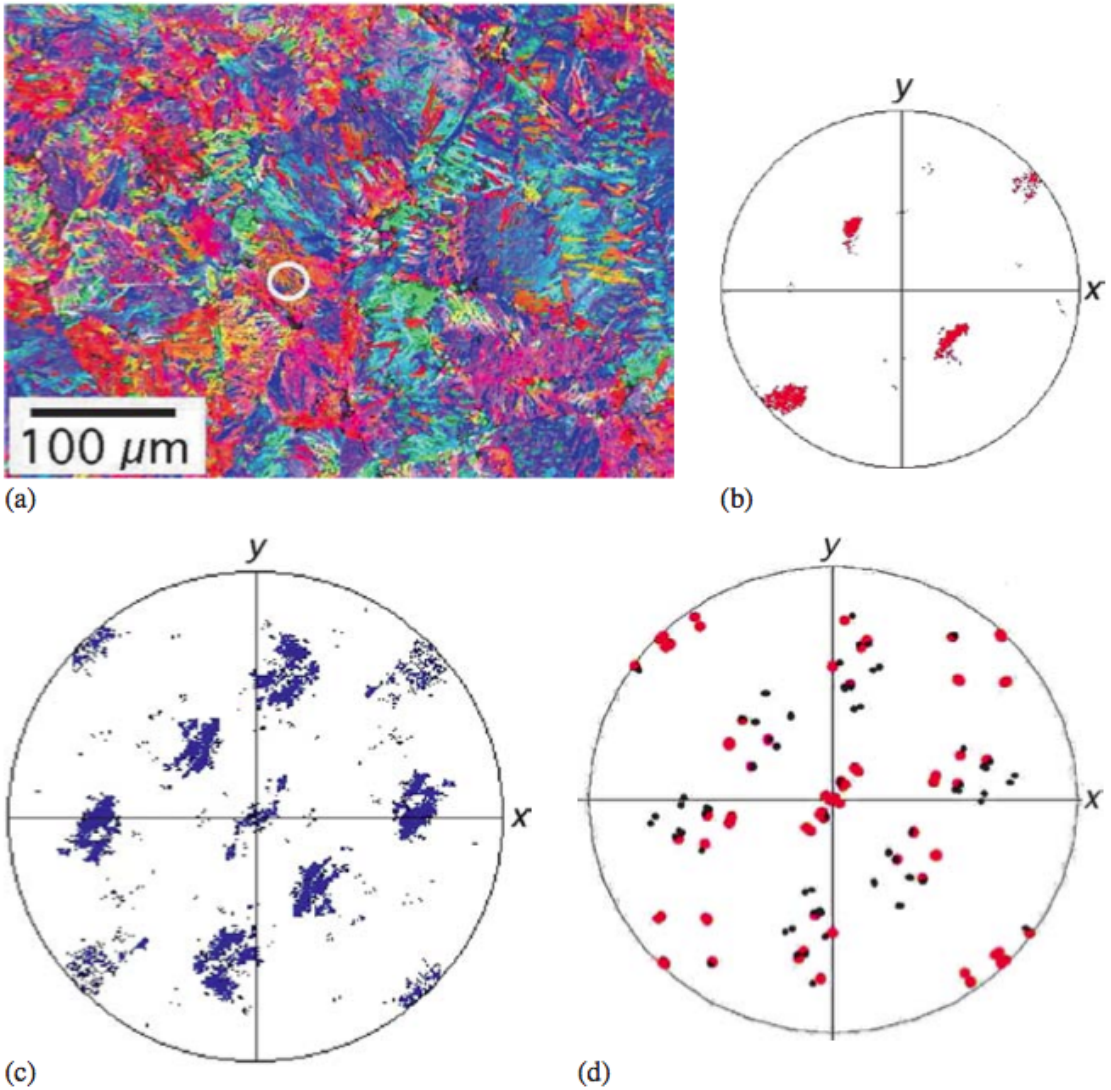


$$\Delta G = \Delta G_{CHEM} + \Delta G_{MECH}$$



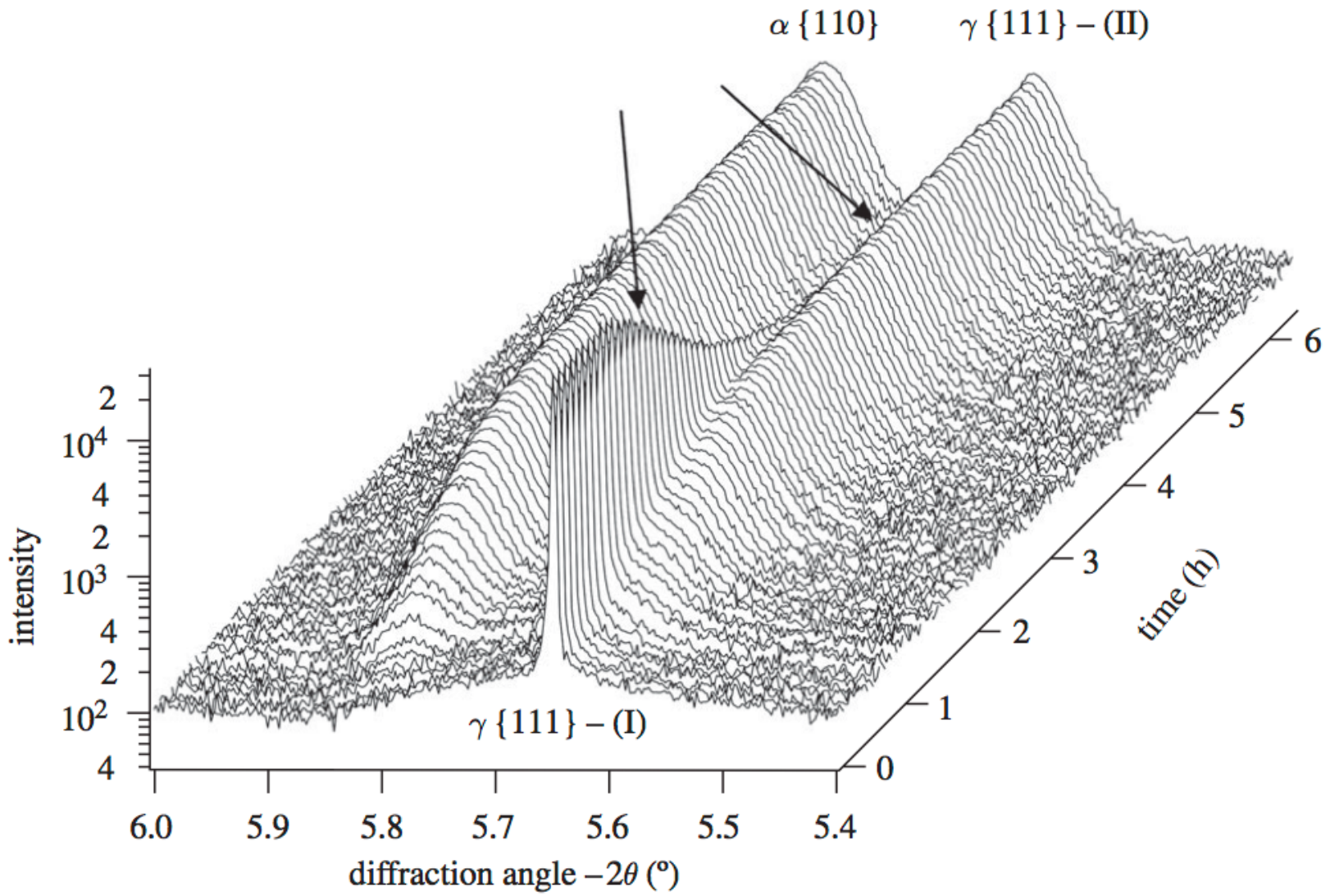


K. Hase, C. Garcia-Mateo and H. K. D. H. Bhadeshia
Materials Science and Technology, **20** (2004) 1499-1505



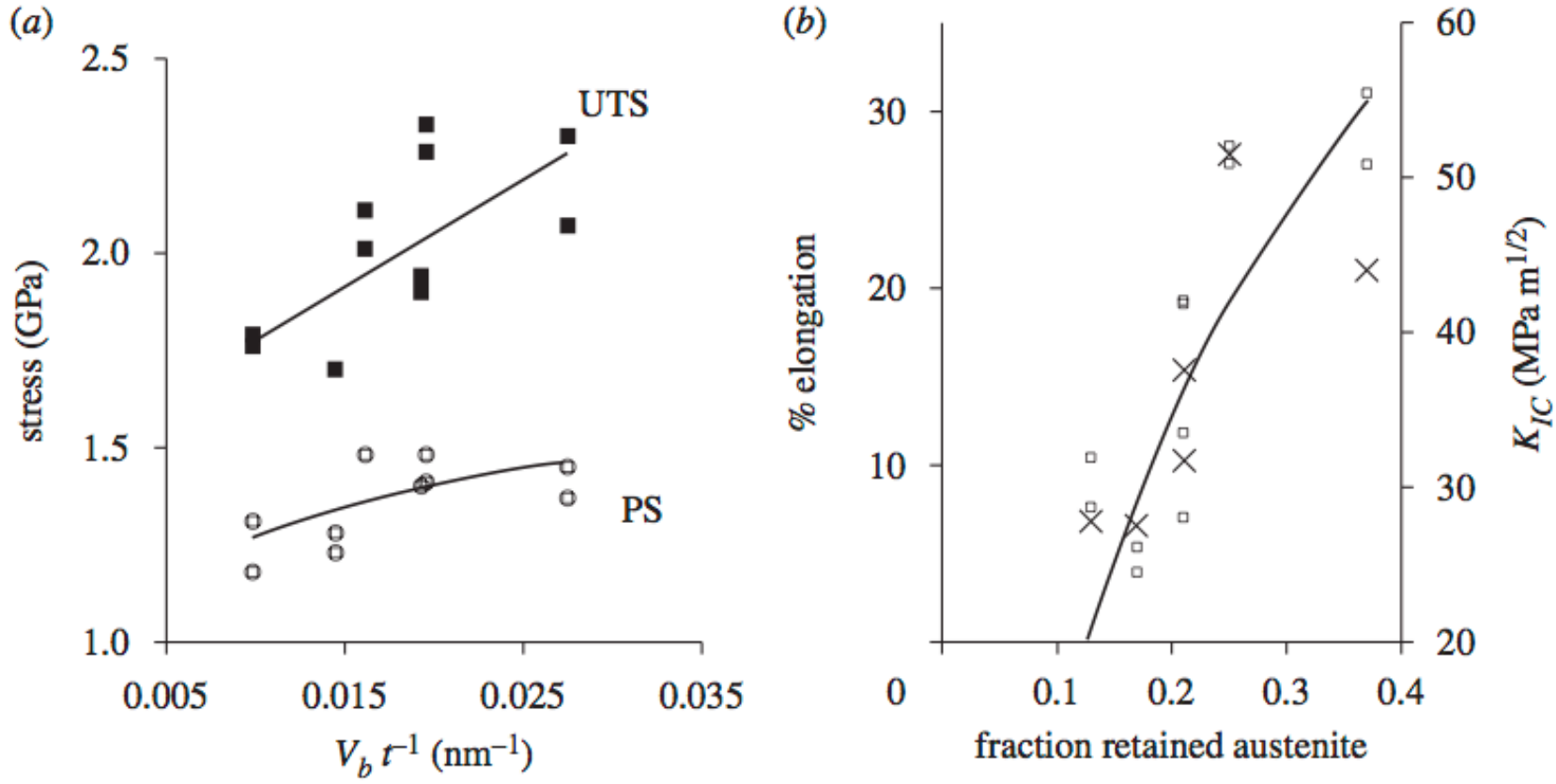
Plastic strain alone does not lead to variant selection

A. A. Shirzadi, H. Abreu, L. Pockock, D. Klobcar, P. J. Wither and H. K. D. H. Bhadeshia
Int. J. Materials Research, **100** (2009) 40-45



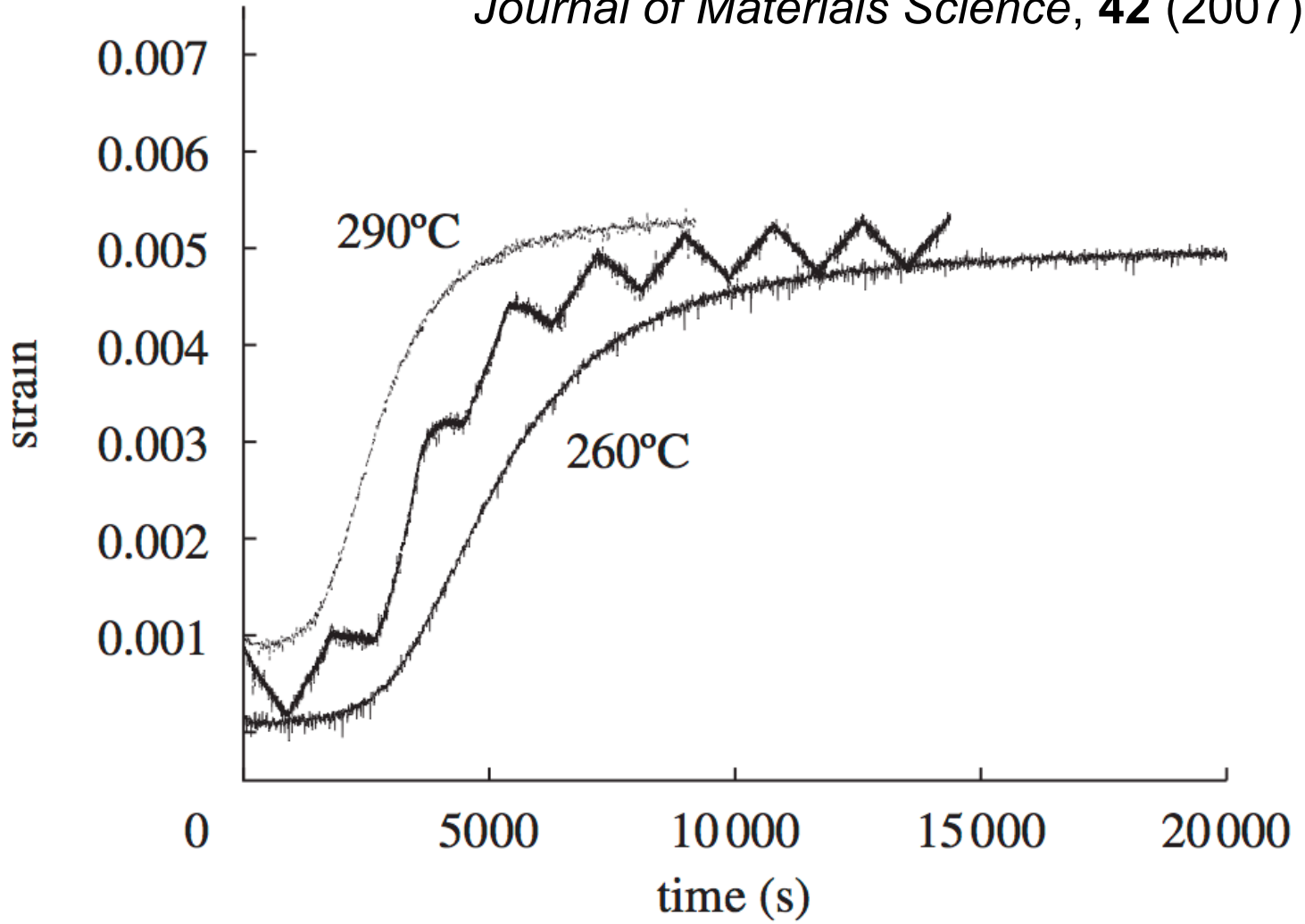
H. J. Stone, M. J. Peet, H. K. D. H. Bhadeshia, P. J. Withers, S. S. Babu, E. D. Specht

Proc. of The Royal Society A, **464** (2008) 1009-1027

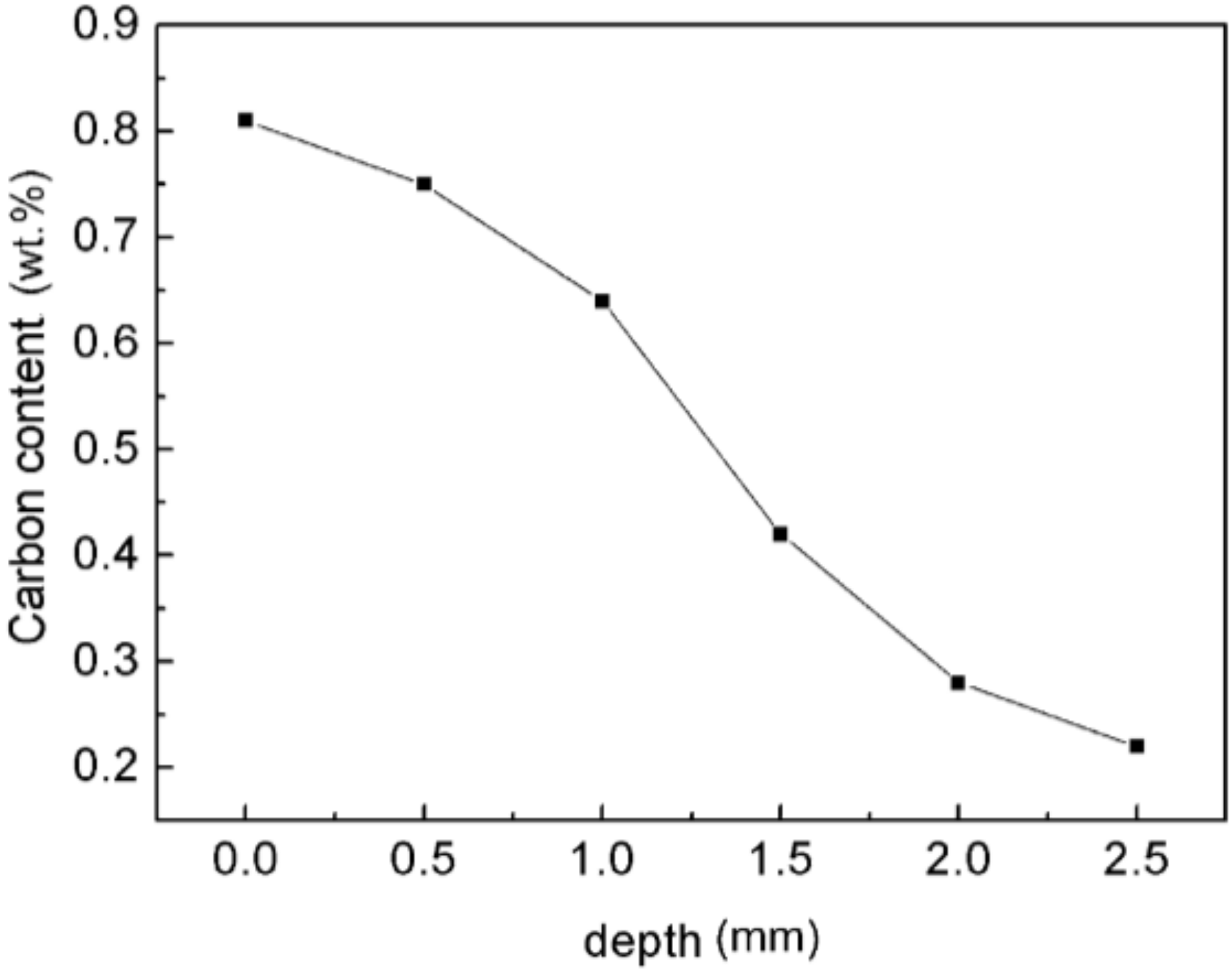


C. Garcia-Mateo and F. G. Caballero
Materials Transactions, **46** (2005) 1839-1846

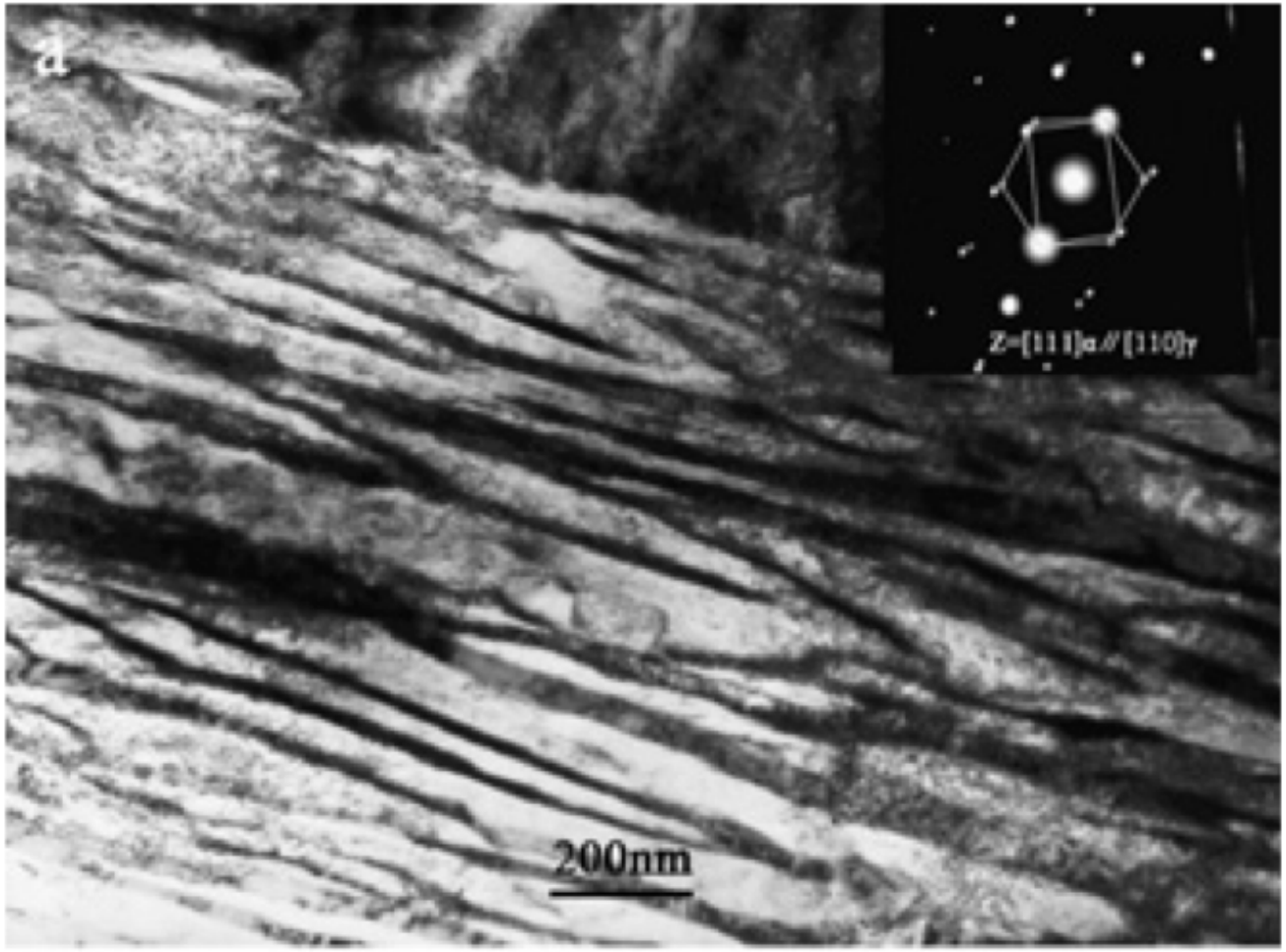
V. Sista, P. Nash and S. S. Sahay
Journal of Materials Science, **42** (2007) 9112-9115



H. S. Hasan, M. Peet, H. K. D. H. Bhadeshia, S. Wood and E. Watson
Mat. Sci. Techn., **26** (2010) 453-456

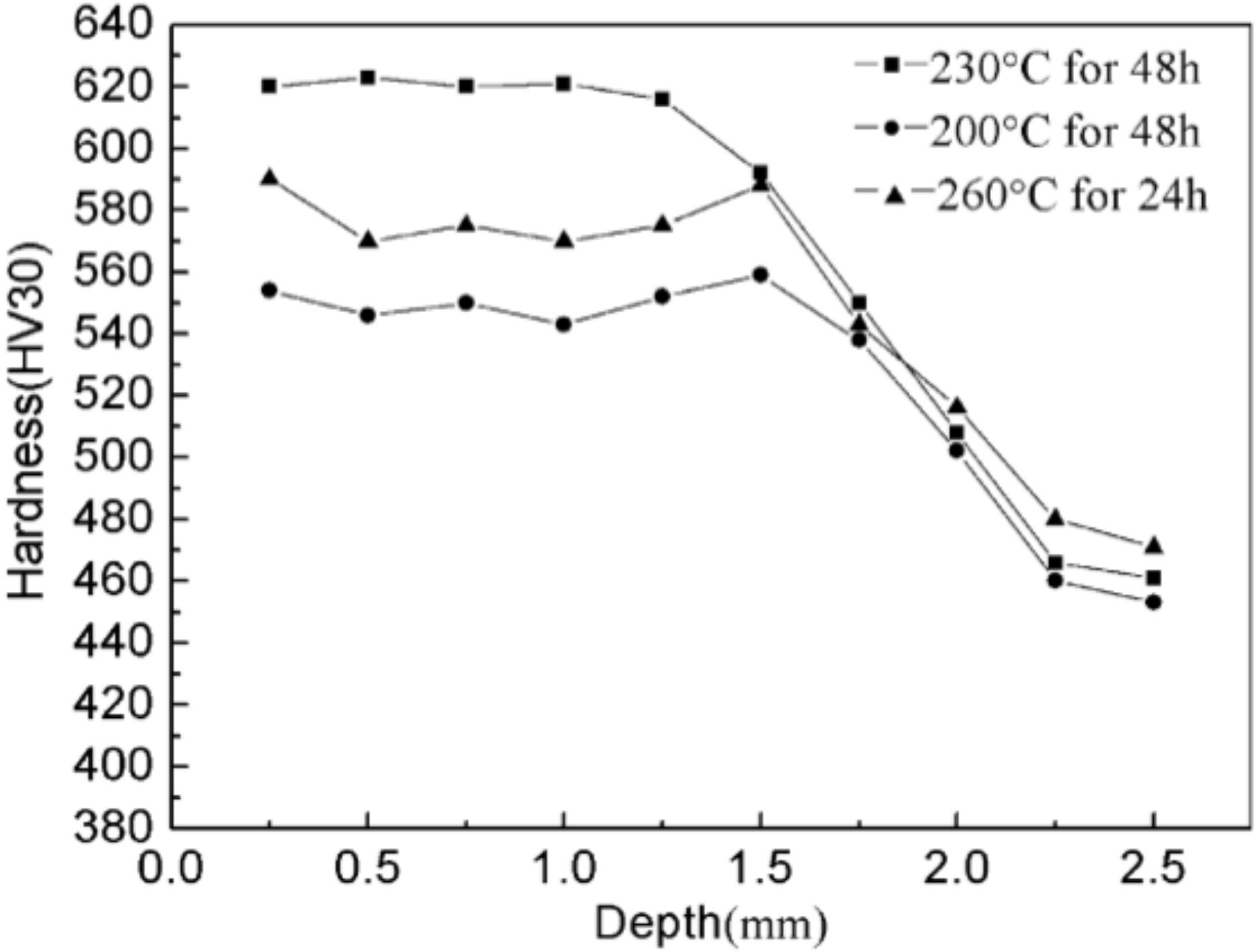

0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
Carbon content (wt.%)
0.0
0.5
1.0
1.5
2.0
2.5
depth (mm)

Fe-0.19C-0.6Si.....

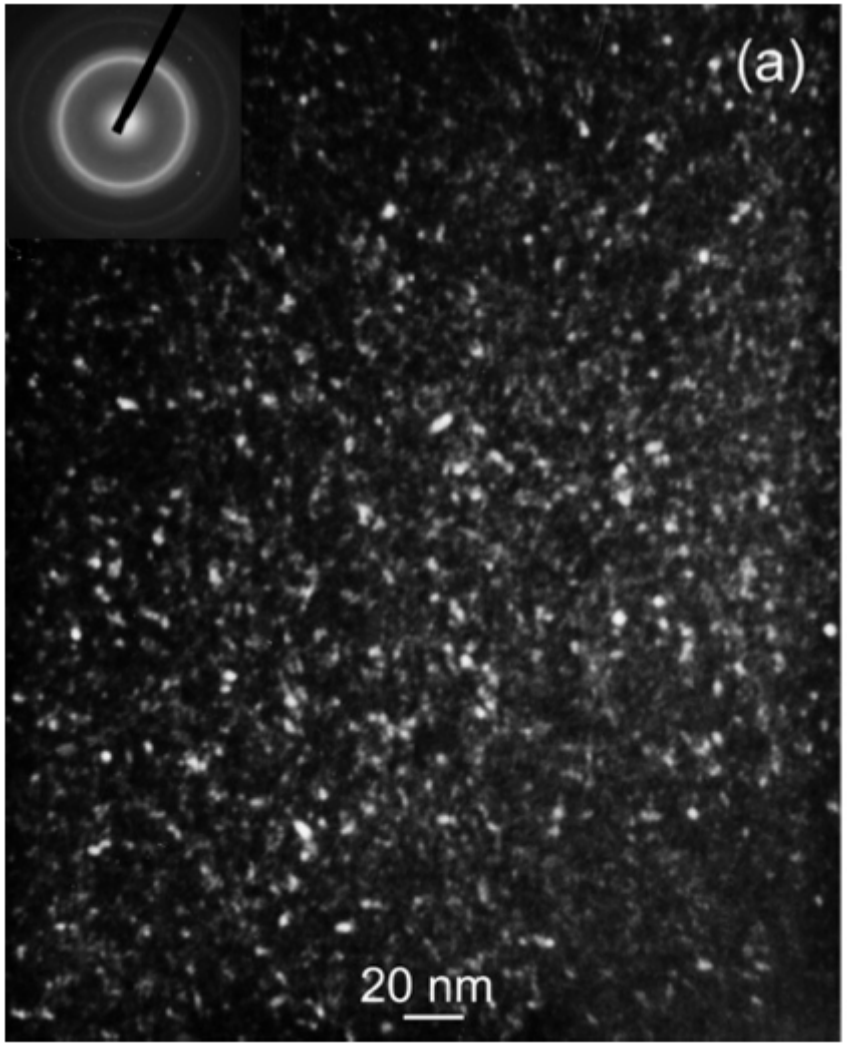


carburise,
transform
at 230 °C
48h

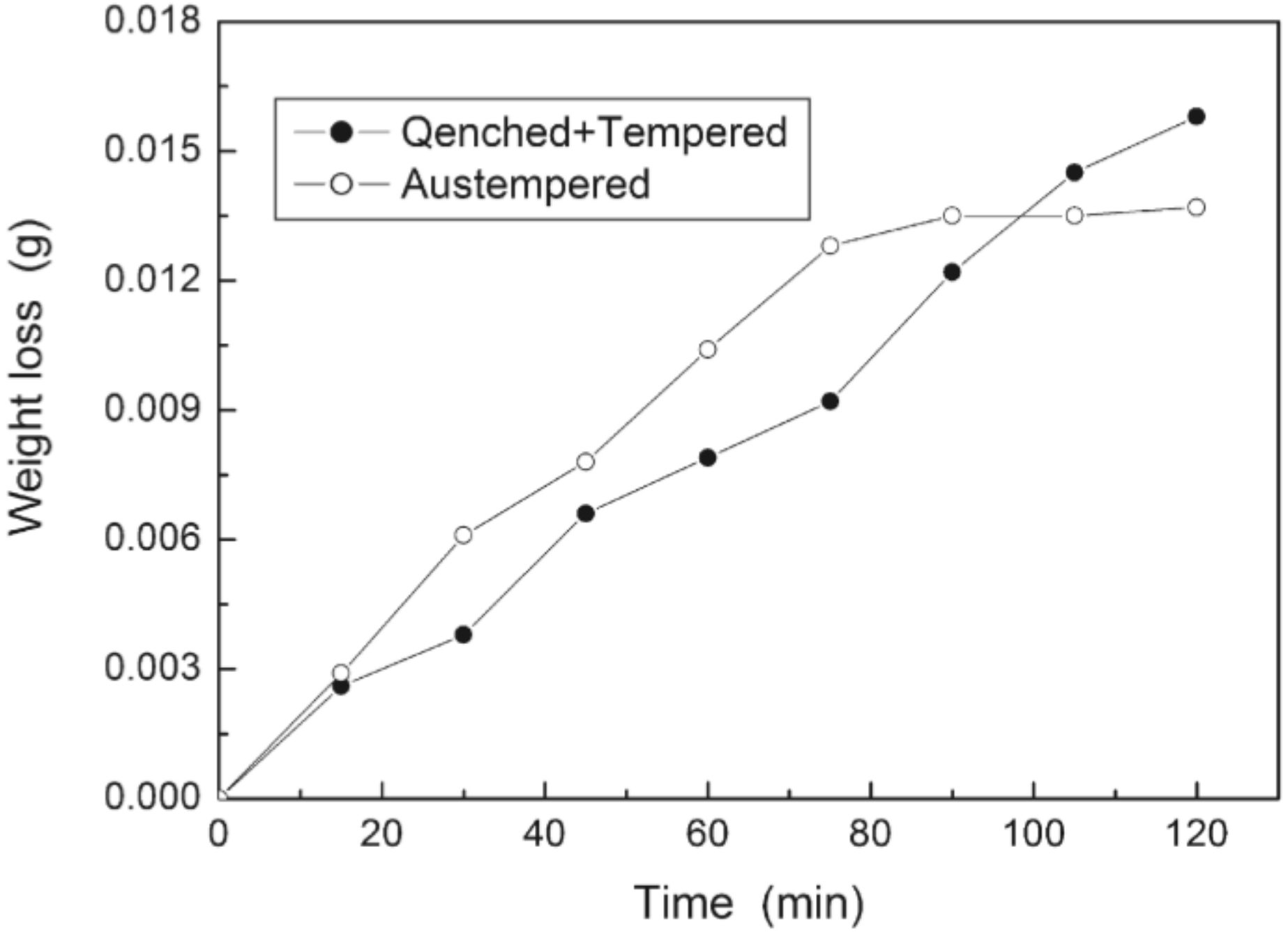
F. C. Zhang, T. S. Wang, P. Zhang, C. L. Zheng, B. Lv, M. Zhang, Y. Z. Zhang
Scripta Materialia, **59** (2008) 294-296


640
620
600
580
560
540
520
500
480
460
440
420
400
380
Hardness(HV30)
0.0
0.5
1.0
1.5
2.0
2.5
Depth(mm)
230°C for 48h
200°C for 48h
260°C for 24h

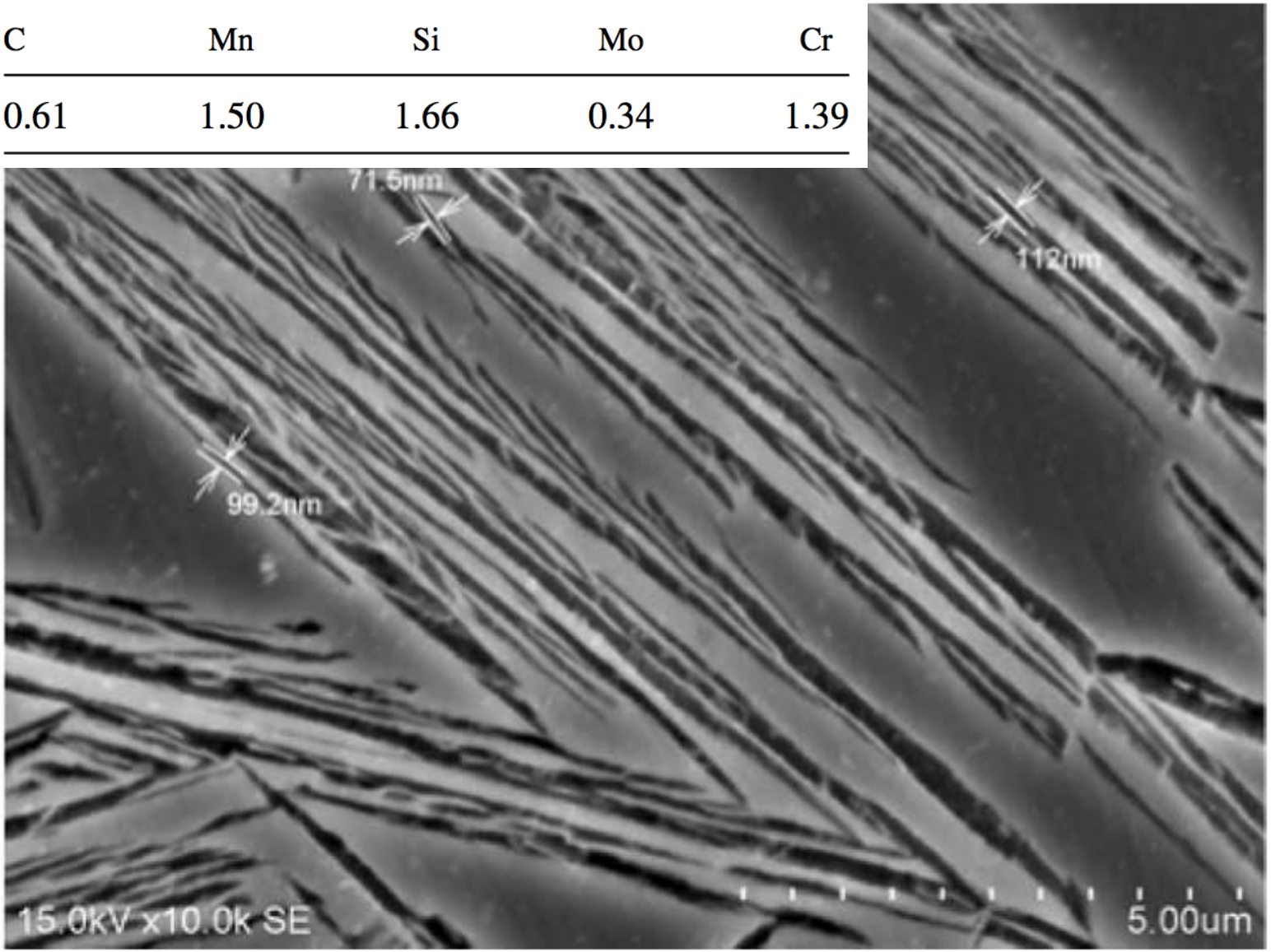
Fe-0.89C-1.43Si..... dry sliding friction



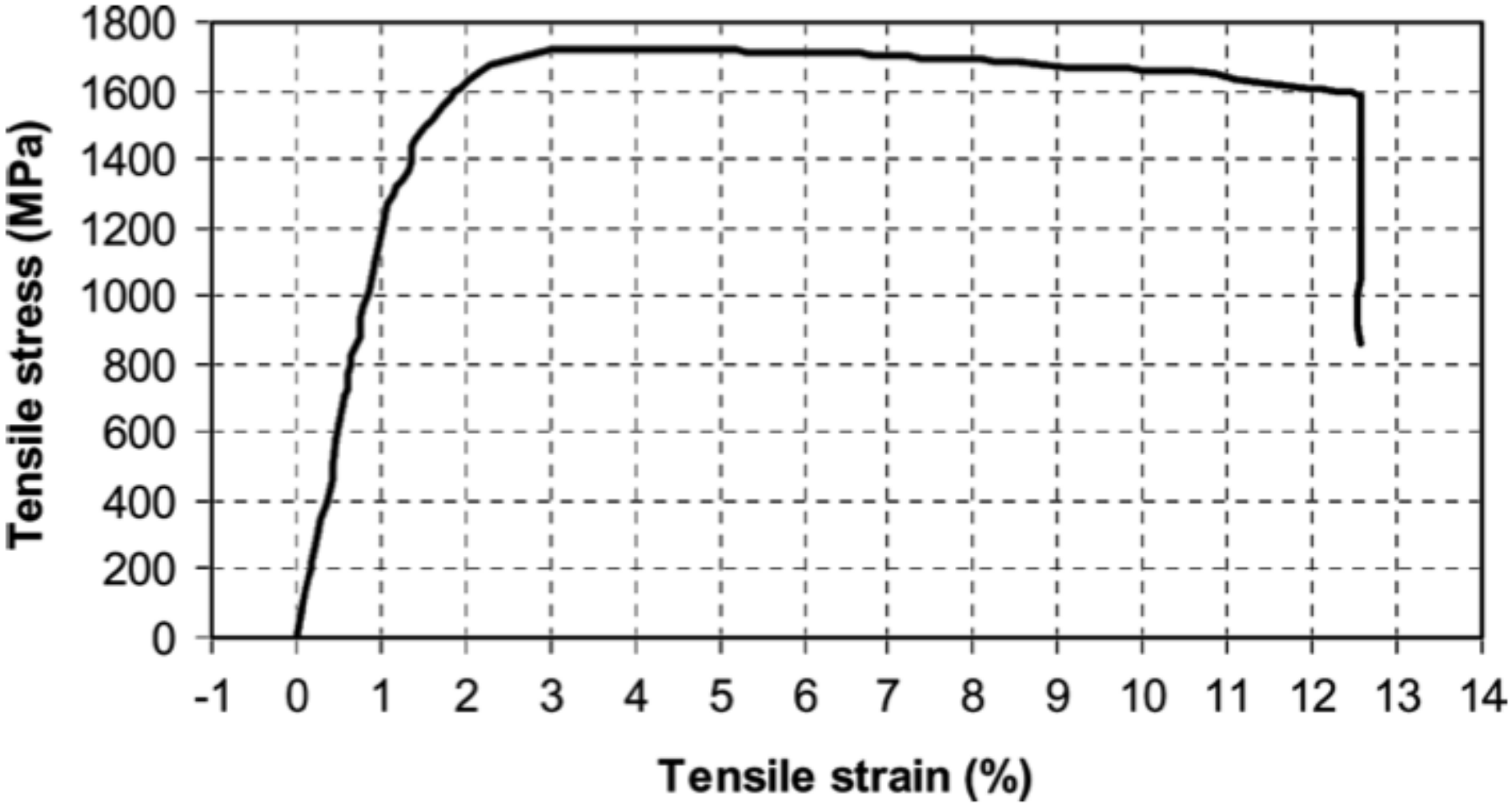
T. S. Wang, J. Yang, C. J. Shang, X. Y. Li, B. Lv, M. Zhang, F. C. Zhang
Surface and Coatings Technology, **202** (2008) 4036-4040


Qenched+Tempered
Austempered
Weight loss (g)
0.018
0.015
0.012
0.009
0.006
0.003
0.000
0
20
40
60
80
100
120
Time (min)

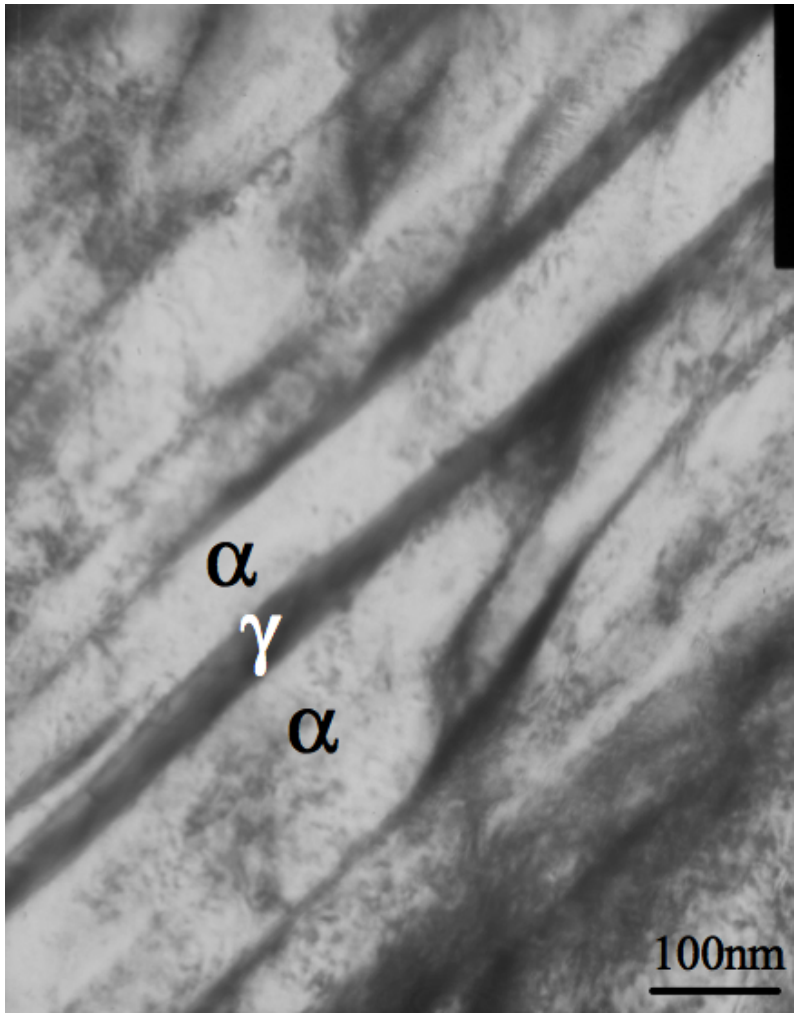
C	Mn	Si	Mo	Cr
0.61	1.50	1.66	0.34	1.39



M. Kundu, S. Ganguly, S. Datta, P. P. Chattopadhyay
Materials and Manufacturing Processes, **24** (2009) 163-173


Tensile stress (MPa)
1800
1600
1400
1200
1000
800
600
400
200
0
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Tensile strain (%)

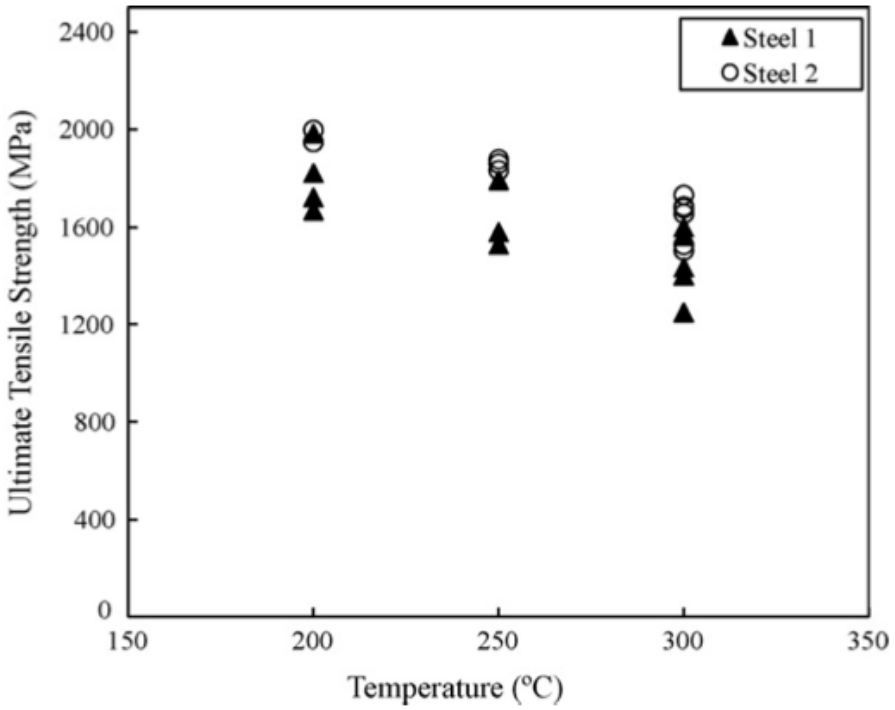
0.79C-1.5Si-1.98Mn-0.98Cr-0.24Mo-1.06Al-1.58Co wt%

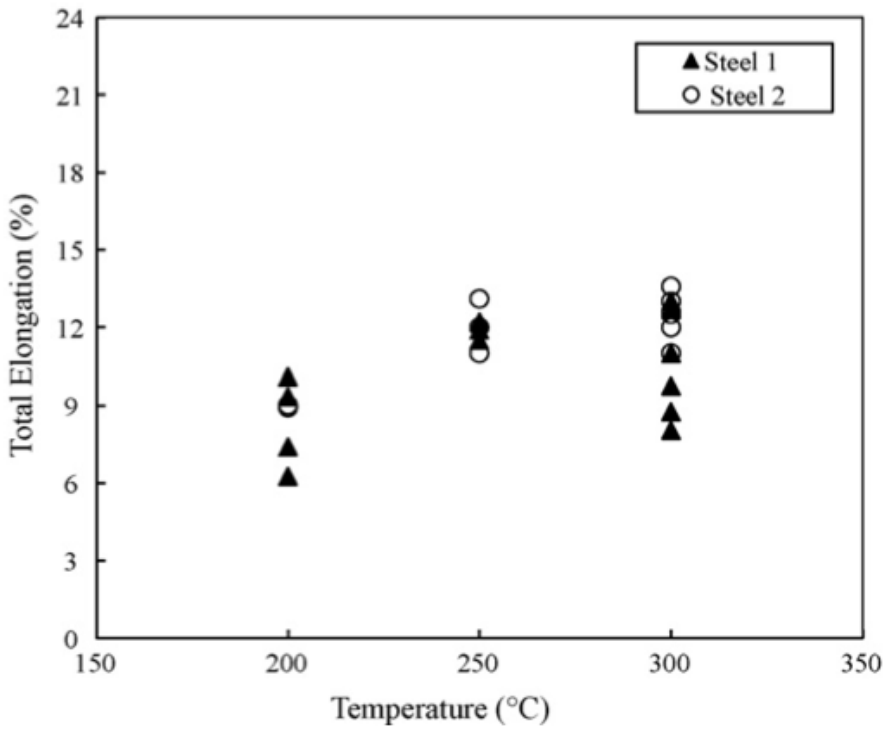


Goal is not entirely clear, but to develop relationship between cystallography and properties

H. Beladi, I. B. Timokhina, S. Mukherjee and P. D. Hodgson
Advanced Materials Research, **97-101** (2010) 2163-2166

C	Si	Mn	Cr	Mo	Co	Al
0.8	1.84	2.18	1.04	0.30	1.31	0.85
0.69	1.92	1.38	1.39	0.24	0.14	0.75



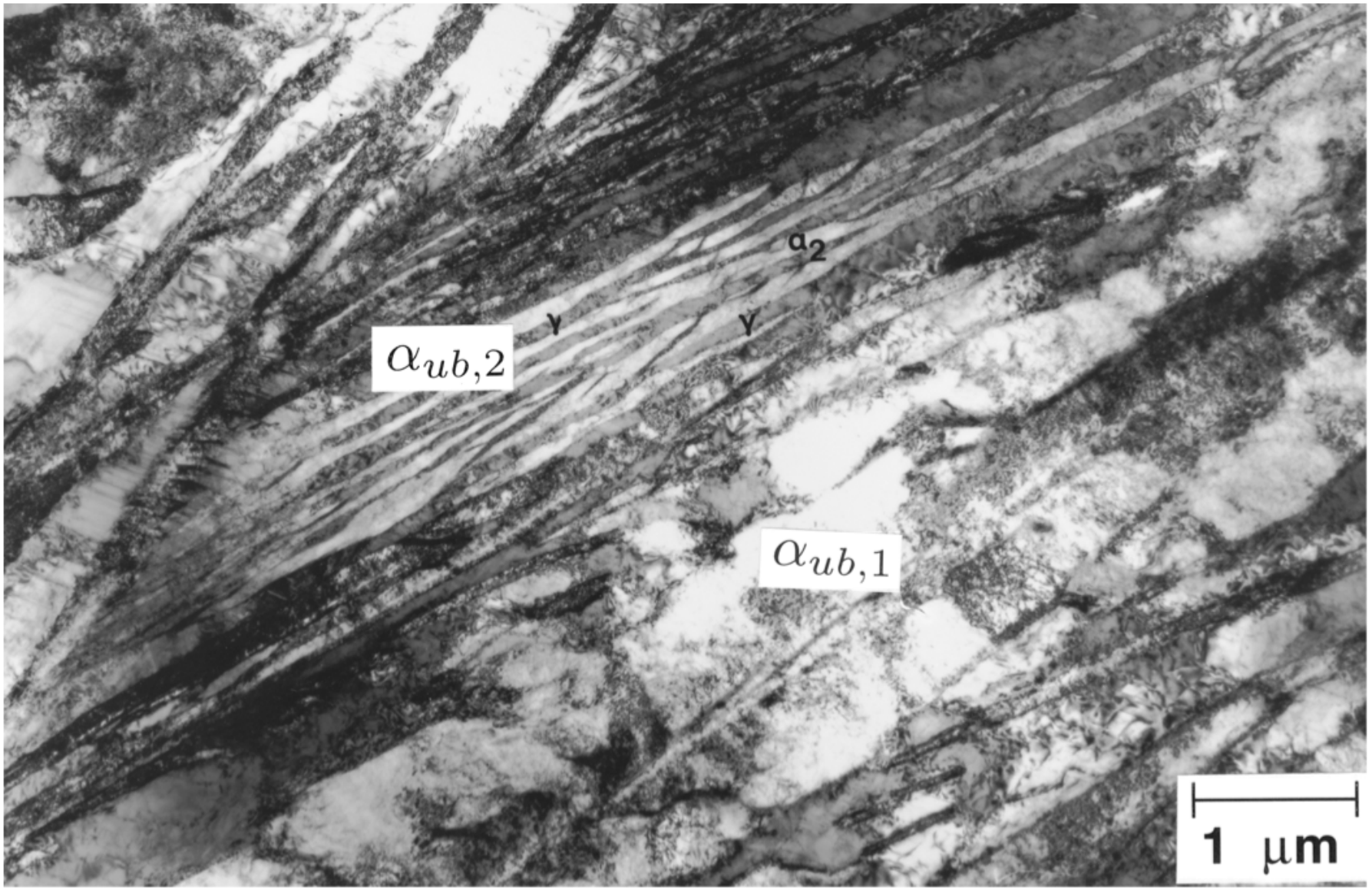


M. N. Yoozbashi and S. Yazdani
Materials Science and Engineering, **527** (2010) 3200-3205

Fe-0.42C-2.03Si..... wt% ... two-step heat treatment

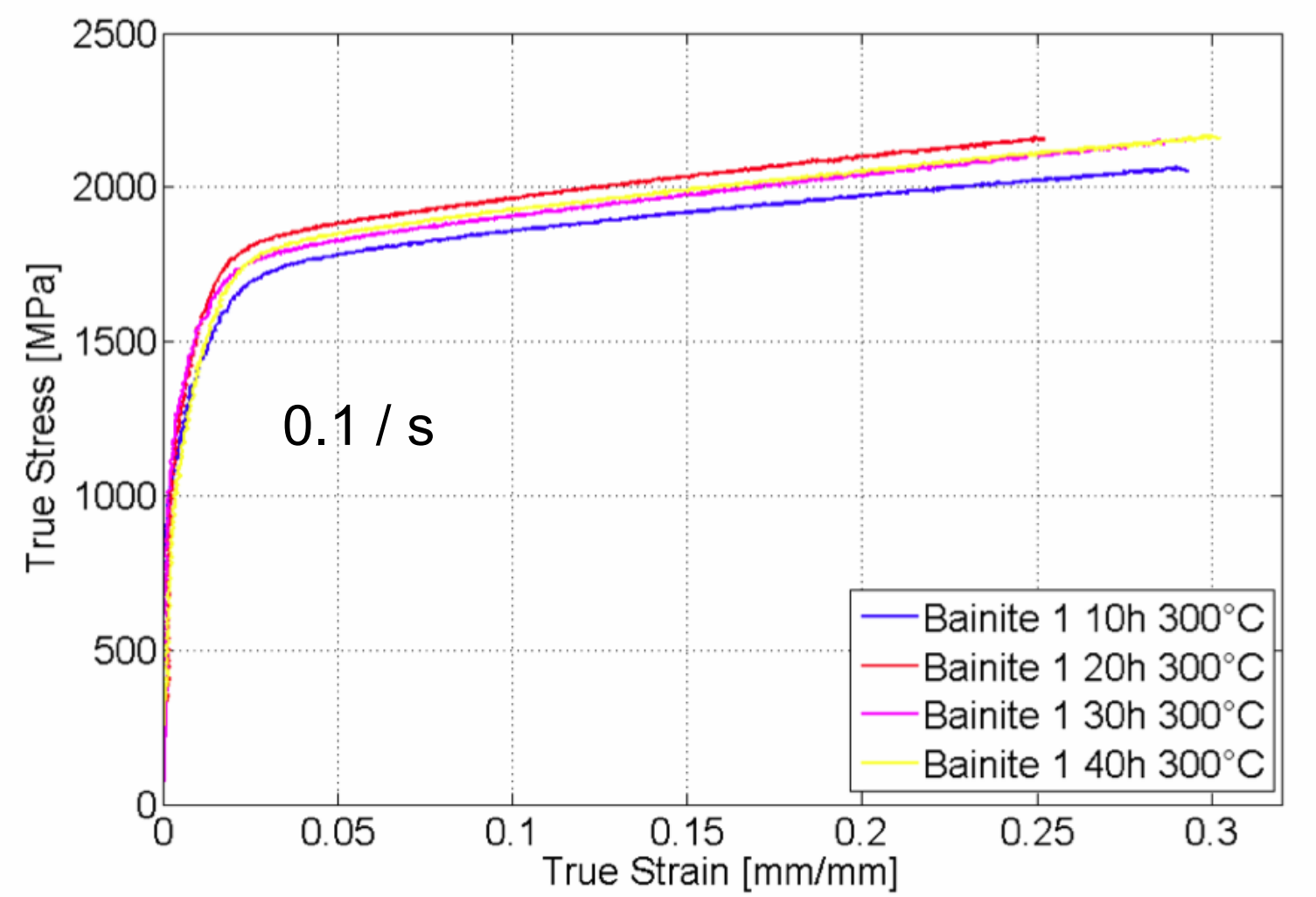
Austempering Temperature °C (°F)	Yield Strength (MPa)	Ultimate Tensile Strength (MPa)	% Elongation	Hardness (HRC)	Strain hardening exponent (n)	Fracture Toughness (MPa√m)
260 °C-288°C (500°F)- (550°F)	1645.8*	1961*	2.4*	52	---	87.4
316°C - 344°C (600°F)- (650°F)	1457.6	1655.0	6.1	47	0.05	98.9
344°C -372°C (650°F)- (700°F)	1363.5	1502.8	8.0	43	0.05	92.7
371°C -399°C (700°F)- (750°F)	1236.5	1381.5	10.6	40	0.05	73.9

K. Putatunda, A. Deokar and G. Bingi
Materials Science Forum, **638-642** (2010) 3453-3458

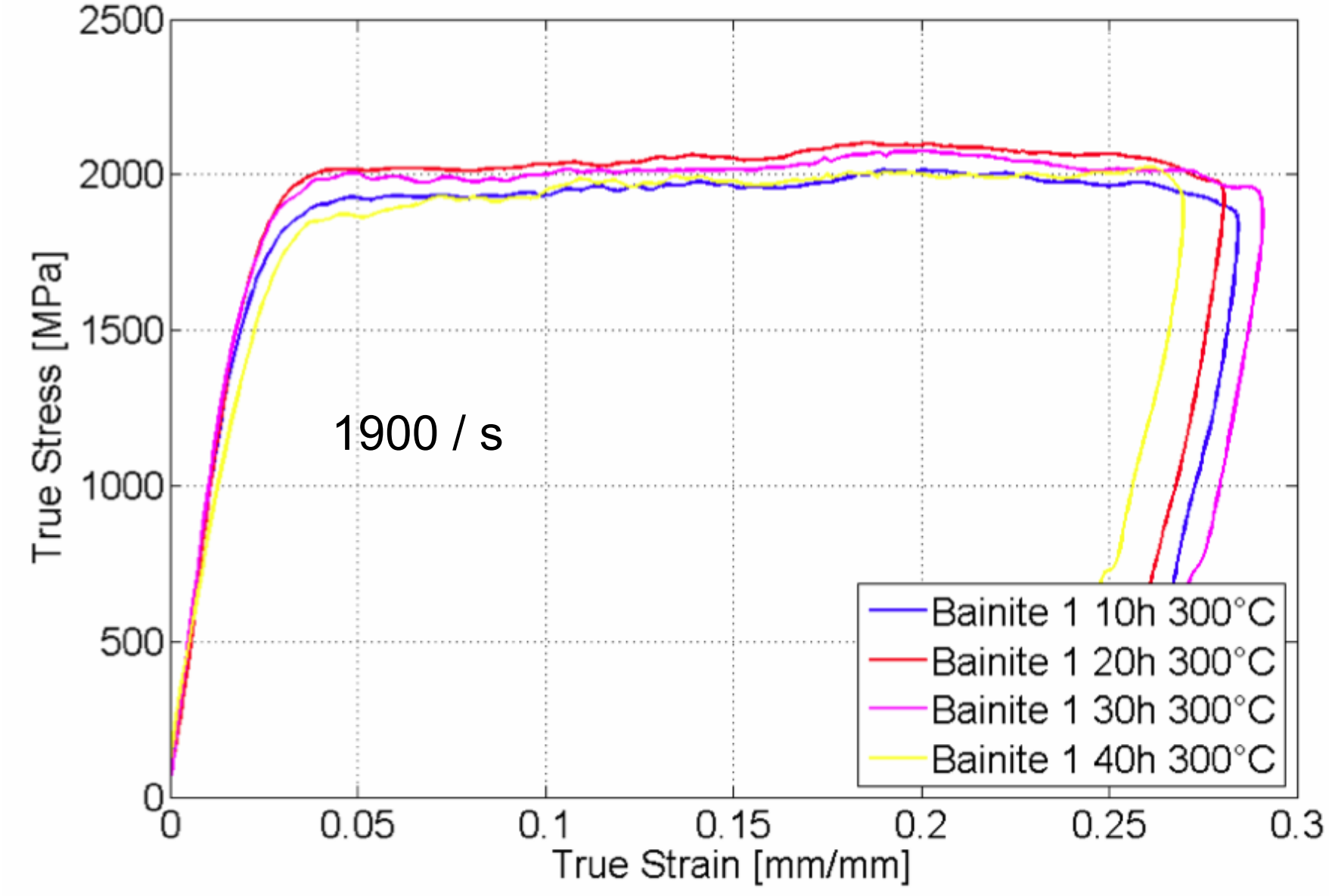


G. Papadimitriou and G. Fourlaris
Journal de Physique IV (C5), **7** (1997) 131-136

Fe 0.4-0.61C 1.7Si....



S. Curtze and M. Kundu and V.--T. Kuokkala and S. Datta and P. P. Chattopadhyay
Society for experimental mechanics, **4** (2008) 2051-2057


2500
2000
1500
1000
500
0
True Stress [MPa]
0
0.05
0.1
0.15
0.2
0.25
0.3
True Strain [mm/mm]
1900 / s
Bainite 1 10h 300°C
Bainite 1 20h 300°C
Bainite 1 30h 300°C
Bainite 1 40h 300°C

Fe 0.8C 2Si..... wt%

austenite 4.5 GPa, bainite 5-7 GPa

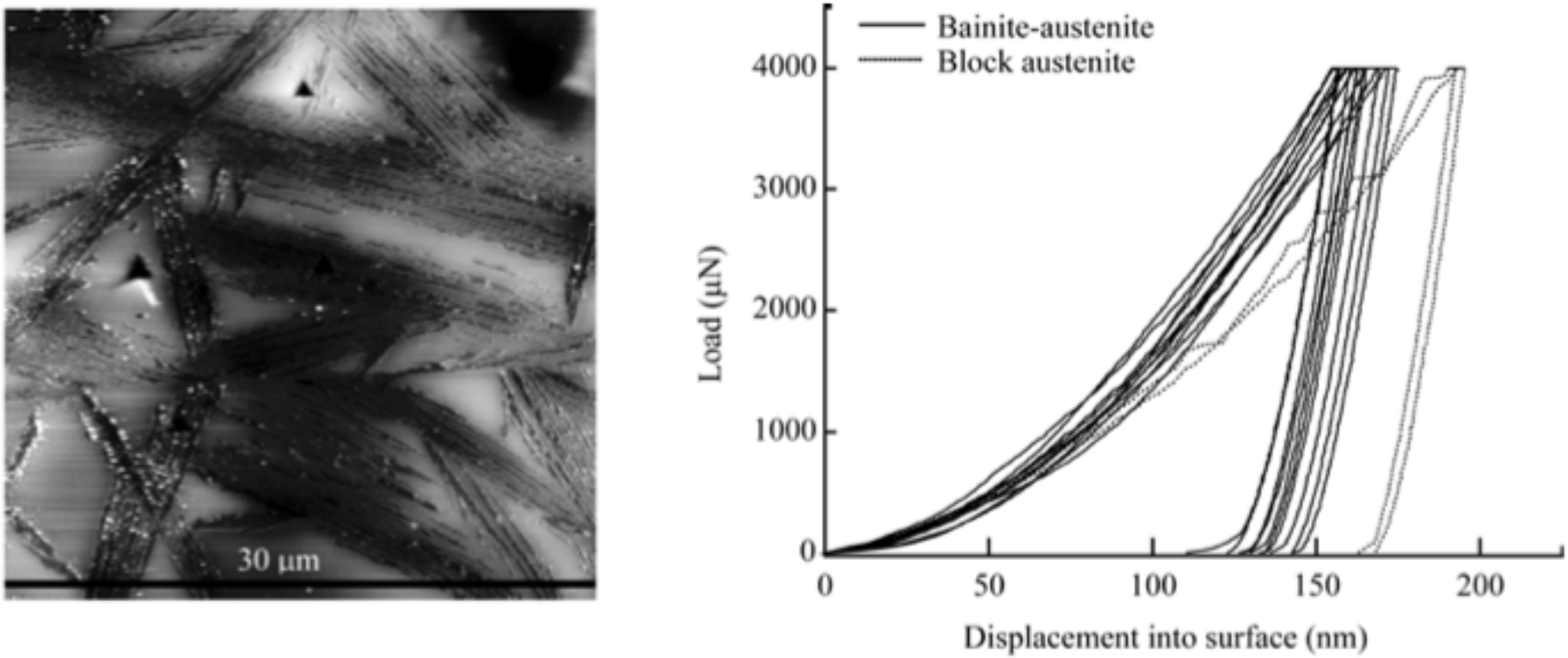


Figure 13 AFM image with nanoindentation and the load curves measured within the corresponding area.

X. Liu, H. Lan, L. Du and W. Liu

Science in China, series E, **52** (2009) 2245-2254

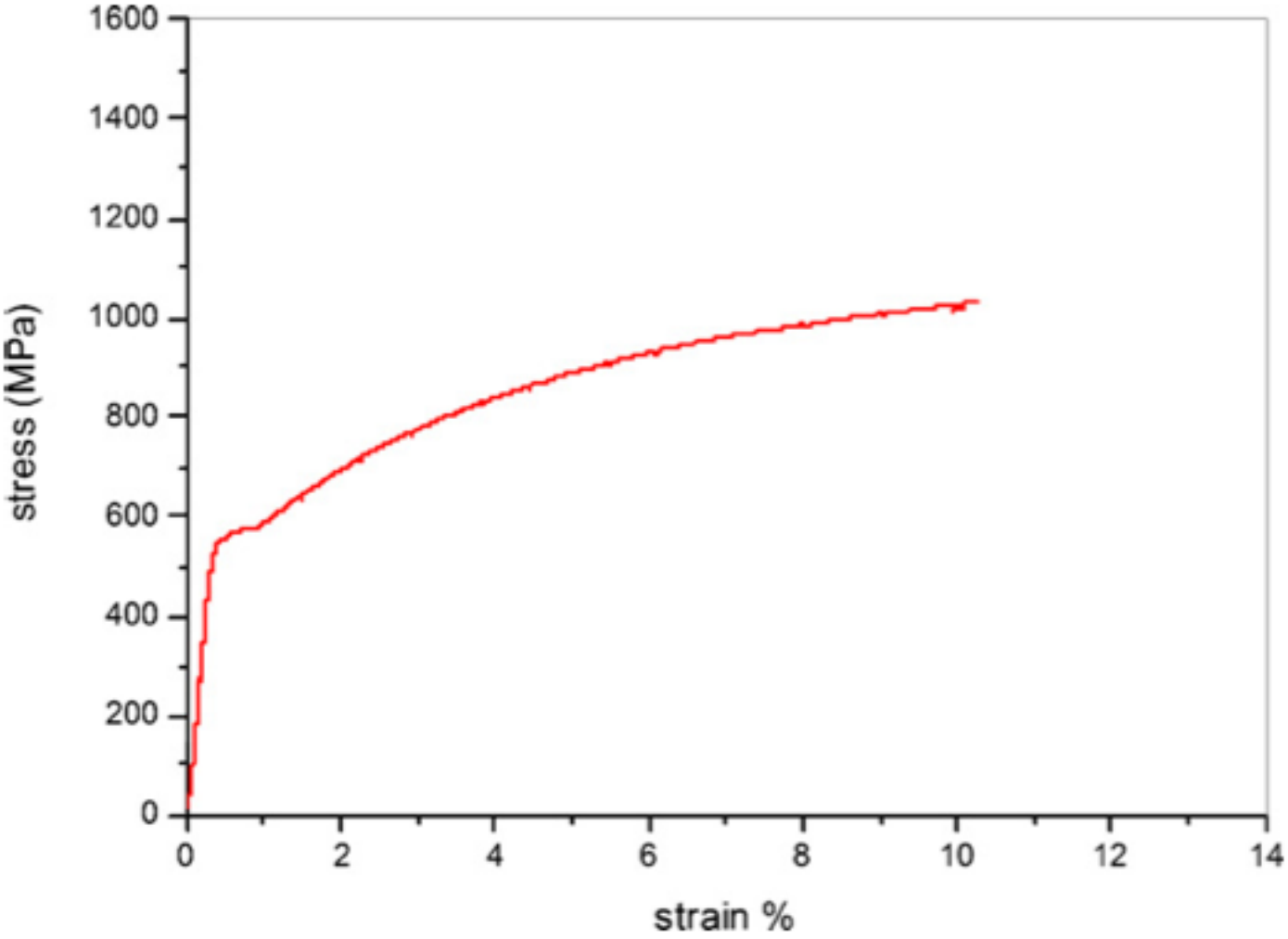
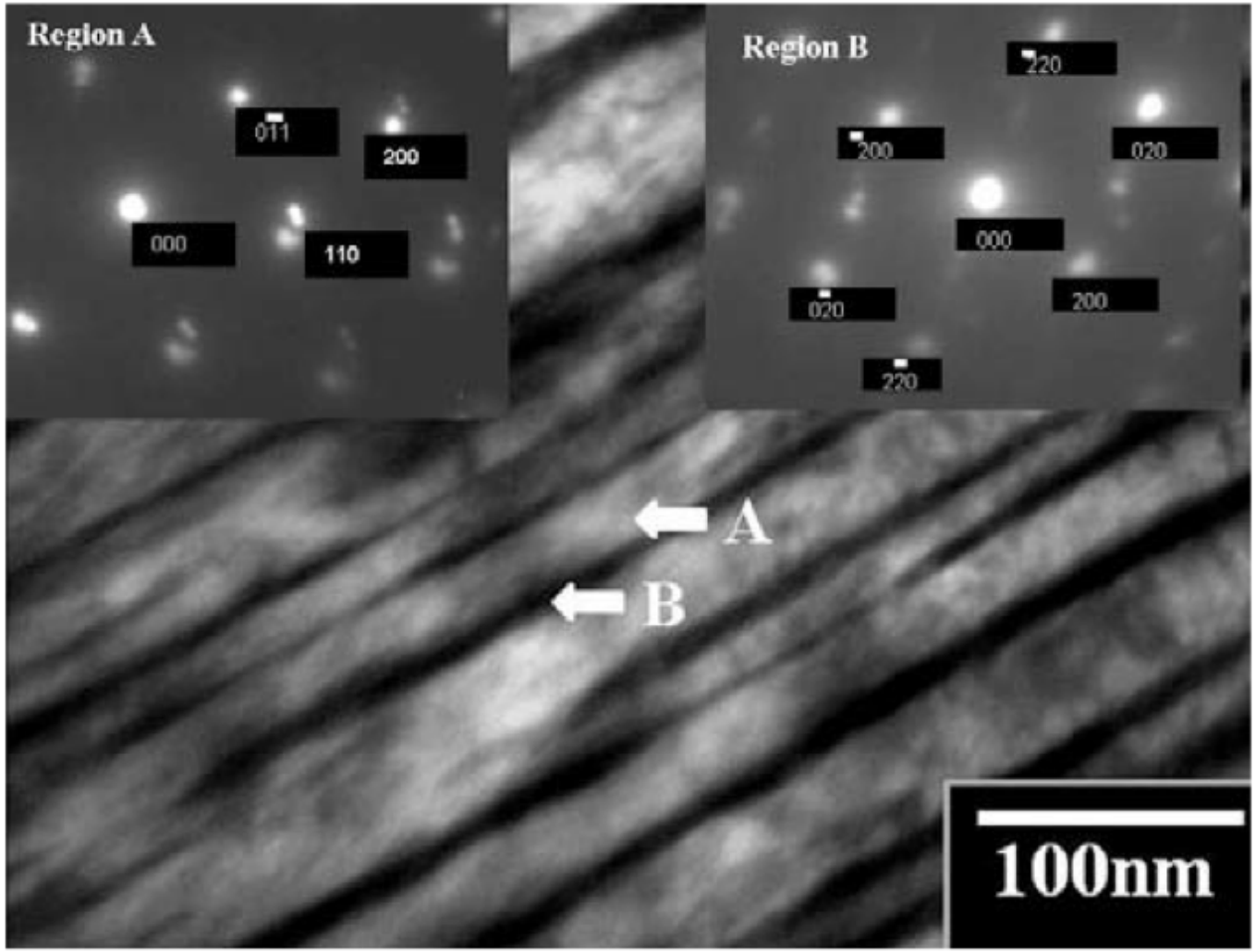


Fig. 11. Stress–strain curve of the 1050 °C sintered material.

C. Menapace, I. Lonardelli, M. Tait and A. Molinari
Materials Science and Engineering, **A517** (2009) 1-7

Fe 1.1C 1.46Cr 0.27Si ... wt% bearing steel



J. Chakraborty, D. Bhattacharjee and I. Manna
Scripta Materialia, **61** (2009) 604-607