doi:10.1017/S1431927613010982
Microsc. Microanal. 19 (Suppl 2), 2013

Dislocations in B2/L2$_1$ $Fe_{30}Ni_{20}Mn_{20}Al_{30}$ after High Temperature Deformation

X. Wu and I. Baker

Thayer School of Engineering, Dartmouth College, 14 Engineering Drive, Hanover, NH 03755

Recently, a range of nanostructured two-phase, high-strength FeNiMnAl alloys has been investigated for their potentially useful mechanical properties. Previous studies using *post-mortem* transmission electron microscope (TEM) observations found that at room temperature two-phase B2/b.c.c. $Fe_{30}Ni_{20}Mn_{25}Al_{25}$, in which the phase widths were ~30 nm, deformed by pairs of *a*/2<111> dislocations gliding on both {110} and {112} slip planes [1]. The separation between the dislocations was relatively wide (20 nm) in the b.c.c. phase, where the dislocations were uncoupled, and narrower (5-7 nm) in the B2 phase, where they were connected by an anti-phase boundary [1]. In contrast, no dislocations were observed in the related two-phase B2/L2$_1$ alloy $Fe_{30}Ni_{20}Mn_{20}Al_{30}$ after room temperature straining [2]. However, slip was found to occur by the glide of *a*<100> dislocations at 873 K, the lowest temperature at which substantial plastic flow was observed [2].

In order to study the deformation mechanism in the two-phase B2/L2$_1$ $Fe_{30}Ni_{20}Mn_{20}Al_{30}$ at high temperature, *post-mortem* TEM analysis was performed on an as-cast $Fe_{30}Ni_{20}Mn_{20}Al_{30}$ specimen, strained ~3% under compression at a strain rate 5×10^{-4} s^{-1} at 1073 K.

Figure 1 shows bright-field TEM images taken under different diffraction conditions. The individual B2 and L2$_1$ phases, which are 5 nm wide, are seen as mottled contrast in the images. The $\boldsymbol{g} \cdot \boldsymbol{b} = 0$ invisibility criterion was used to determine the Burgers vectors of the dislocations present. Table 1 summarizes the diffraction conditions used and the dislocation's visibility. The dislocations arrowed were out of contrast for both $\boldsymbol{g} = B2[1\bar{1}0], L2_1[2\bar{2}0]$ and $\boldsymbol{g} = B2[\bar{1}00], L2_1[\bar{2}00]$ but were in contrast for the other g vectors shown. Therefore, the Burgers vector of these dislocations is given by the cross product of the two g vectors that give invisibility, i.e.: $\boldsymbol{b} = [1\bar{1}0]\times[\bar{1}00] = [001]$. The projected directions of the dislocation lines were found to be perpendicular to $[1\bar{1}0]$ when viewed along [111] and $[\bar{3}10]$ when viewed along [001]. Thus, the line direction of these dislocations is given by $\boldsymbol{u} = [1\bar{1}0]\times[\bar{3}10] = [001]$, i.e. the dislocations were screws.

References

[1] J. A. Loudis and I. Baker, "Dislocation Identification and *in situ* Straining in the Spinodal $Fe_{30}Ni_{20}Mn_{25}Al_{25}$ Alloy, Microscopy Research and Technique. 71 (2008): 489-496.
[2] X. Wu and I. Baker, "Dislocations in Nanostructured Two-Phase $Fe_{30}Ni_{20}Mn_{20}Al_{30}$", Microscopy Research and Technique, in press. DOI: 10.1002/jemt.22162.
[3] Research supported by the US Department of Energy, Office of Basic Energy Sciences grant DE-FG02-07ER46392).

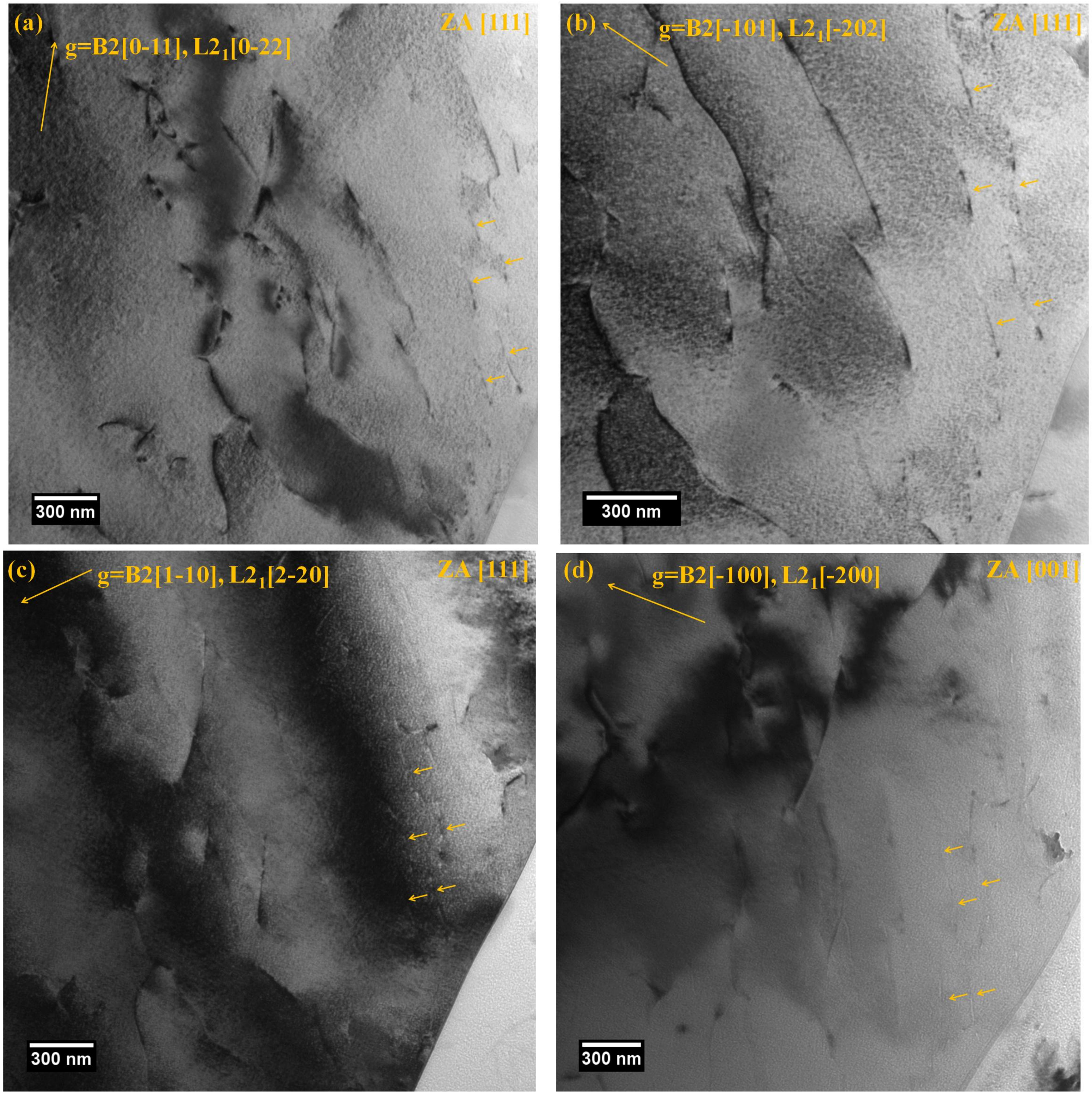

Figure 1. Bright-field TEM images of $Fe_{30}Ni_{20}Mn_{20}Al_{30}$ strained at 1073 K showing dislocations under different two-beam conditions. Details of the analysis are given in the text. The Burgers vector of the dislocations arrowed is [001].

Table 1. Burgers vector and visibility for arrowed dislocations shown in Figure 1 imaged using the diffraction vectors shown. (O: visible; X: invisible).

Burgers Vector	$B2[0\bar{1}1]$ $L2_1[0\bar{2}2]$	$B2[\bar{1}01]$ $L2_1[\bar{2}02]$	$B2[1\bar{1}0]$ $L2_1[2\bar{2}0]$	$B2[\bar{1}00]$ $L2_1[\bar{2}00]$
[001]	O	O	X	X

https://doi.org/10.1017/S1431927613010982 Published online by Cambridge University Press