doi:10.1017/S143192761101004X
Microsc. Microanal. 17 (Suppl 2), 2011

Observation of Side Bands Modulated Structure in $FeTiO_3$-Mn_2O_3 Alloys

Mohammad Shamsuzzoha[1], Chandan Srivastava[2], Pranoti Kale[3], Padmini Periaswamy[3], Sushma Kotru[3] and Raghavendra Pandey[3]

[1] School of Mines and Energy Development, [2] Department of Metallurgical and Materials Engineering, [3] Department of Electrical and Computer Engineering, University of Alabama, Tuscaloosa, Alabama.

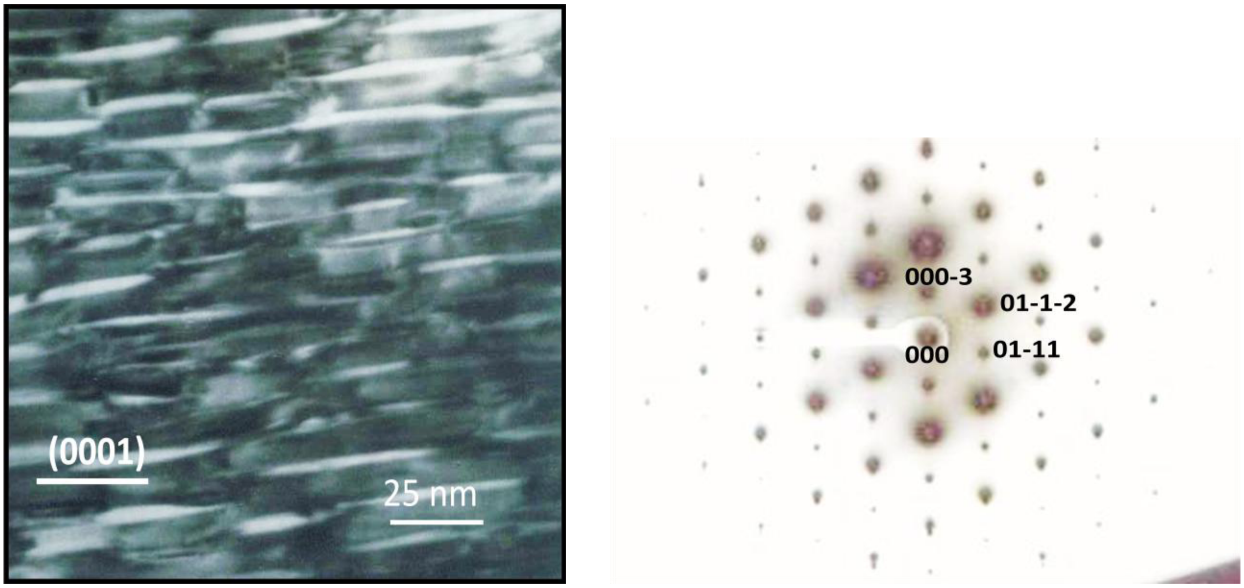
Composition or elemental distribution related modulated side band structure resulting from the decomposition of supersaturated solid solution in binary and ternary alloys yields useful insight into the kinetics of solid solution. Side bands in diffraction patterns were originally discovered by Bradley [1] in cubic Cu-Ni-Fe alloys. Later, Danial & Lipson [2] revealed that the side band structure in such cubic alloys arises from the microstructure that is composition-modulated along <100> due to a periodic or wave-like clustering of solute. This paper provides the observation of side bands structure found in a hexagonal alloy of $FeTiO_3$. The investigated alloys of $FeTiO_3$ containing between 0 to 40 mol% of Mn_2O_3 were prepared by the standard ceramic processing techniques in which sintering was performed at a temperature of 1200ºC for 12 hours in an Argon gas environment.

Figure 1a shows a TEM bright field micrograph of ilmenite-35% Mn_2O_3 alloy taken with the electron beam closely aligned along a direction that appears as [01-10] zone axis of the parent ilmenite crystal. The micrograph exhibits modulation bands in the microstructure of the ilmenite containing 35% Mn_2O_3. Its associated diffraction patterns are also given in figure 1b. The diffraction pattern exhibits slight deviation from the 2- fold symmetry that is normally observed in a pattern that is taken along [01-10] of a hexagonal crystal. The pattern is therefore considered to be arising from a structure that is slightly distorted from the rectangular symmetry and probably belongs to a quasi-periodic phase. The diffraction pattern is indexed on the basis of that obtained for [01-10] of parent ilmenite phase. The pattern exhibits side band satellite streaks extending along [0001] of the fundamental spots. It also shows the streak length remains constant with the diffraction vector in the pattern. Furthermore, the length of diffraction streak present in the fundamental reflections of the pattern belonging to other orientations of the sample also remains constant with its direction vector. A combined analysis of all these diffraction phenomena indicates that the satellite streaks in the pattern of Figure 1b are due to composition distributed modulation bands that are stacked on the (0001) plane of the crystal of the parent ilmenite crystal. The variation of contrast in the bands suggests a composition modulation along <0001> of the crystal due to a periodic clustering of Mn. STEM/EDS line profiles across and normal to these side bands showed a wave form variation in the composition of Mn. Figure 2 shows a STEM/EDS line profile as taken across a few side bands. The line profile shows the existence of cyclic variation of Mn content for which the maxima correspond to the darker region. The average period in the STEM/EDS line profile of Figure 2 is about 70 nm, which agrees reasonably well with that found from the average width of the side bands.

References

[1] A. J. Bradely, Proc. Phys. Soc., 52(1940), 80.

[2] V. Daniel and H. Lipson, Proc. Roy. Soc., A182 (1944), 378.



(a) (b)

Figure 1 (a) TEM bright field micrograph showing a group of modulated side bands present in the microstructure of the ilmenite containing 35% Mn_2O_3.(b) Electron diffraction patterns taken of (a).

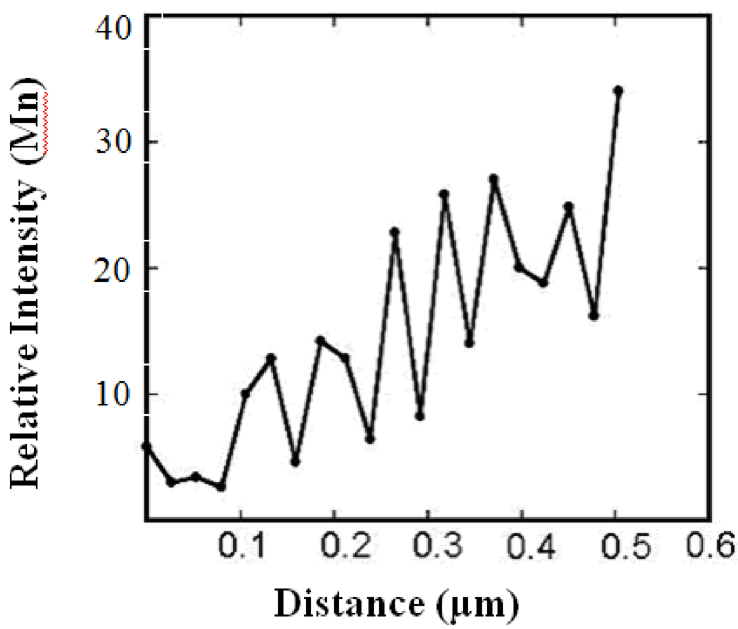


Figure 2. A typical STEM/EDS line profile taken across a few side bands of Figure 1a.

https://doi.org/10.1017/S143192761101004X Published online by Cambridge University Press