

Aberration-Corrected STEM Analysis of Transformation Mechanism of LPSO in Mg-Zn-Y Alloys

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Mg-based alloys have attracted much attention as next-generation lightweight structural materials because of their low density, high specific strength, damping capacity, recycling efficiency, and other features. A series of novel structures that show so-called “synchronized long-period stacking order (LPSO)” in Mg-TM-RE alloy systems (where “TM” and “RE” denote transition metal and rare earth) has recently been reported [1]. Synchronized LPSO signifies the segregation of TM and RE elements into stacking faults and the long-range ordering of the segregated stacking faults. Many researchers have previously examined the atomic-level structure of the LPSO in Mg-Zn-Y alloys. The 10H, 14H, 18R, and 24R polytypes are found in this alloy, depending on the thermal history of the alloy and the concentration of solute in the alloy [2, 3]. Although the formation and growth mechanism of the LPSO have not been elucidated in a long time, Zhu *et al.* recently proposed a mechanism for the transformation of LPSO structure in Mg_{96.7}Zn_{0.8}Y_{2.4}Zr_{0.2} alloys. They also showed that the 24R-type irregularity plays a role in the transformation, the details of the mechanism has not been clarified. In the present study, it has been examined the transformation mechanism from the points of structural and compositional irregularities in the LPSO in Mg₉₇Zn₁Y₂ and related alloys. The irregularity of the LPSO structure was examined using aberration-corrected high-angle annular dark field scanning transmission electron microscopy (HAADF-STEM) and peak-pair analysis (PPA) [5].

Fig. 1 shows a Bragg-filtered HAADF-STEM image taken around a transition region in an LPSO band [6]. Two Burgers circuits clearly show that a pair of Shockley partial dislocations with $\mathbf{b} = 1/3[01-10]$ and $\mathbf{b} = 1/3[0-110]$ exist at both sides of the hexagonal close-packed (HCP)-like region. These partial dislocations indicate the existence of a pair of ledge structures. However, the structure gradually changes from a face-centered cubic (FCC) structure to an HCP-type one. The structure in the transition region seems to be a strained HCP-type structure. The A' stacking layer moves by the two close-packed (0001)_{Mg} planes across the transition region; the stacking order locally changes from left to right B'→C, C→A', B→B'. Here, A', B', and C' denote solute enrichment layers with different stacking planes in an FCC-type stacking sequence. The Z²-contrast of the transition region is lower than that of the normal enrichment layer of an FCC-type stacking sequence, meaning that the solute elements can easily migrate across (0001)_{Mg} planes in the transition region. Consequently, the LPSO structure would change through a type of diffusional-displacive transformation.

Fig. 2 shows (a) an HAADF-STEM image and (b–d) show strain mappings around the transition region of an enrichment layer obtained from the PPA of the HAADF-STEM image. Here, the strain was measured relative to the lattice spacing of the nonenrichment layer. The in-plane normal strain map in Fig. 2(b) shows homogeneous contrast. This result means that the interface between the enrichment layer and the nonenrichment layer is actually coherent. The out-of-plane normal strain

