Mg alloys containing ternary Mg-TM(Transition-metal)-RE(Rare-earth) phases with long-period stacking-ordered (LPSO) structures have received a considerable amount of attention in recent years. Although reasons why these alloys can simultaneously exhibit high strength and high ductility have been remained largely unsolved, ternary LPSO phases have been believed to play important roles in endowing them with excellent mechanical properties. Mg-Zn-RE LPSO phases are reported to consist of structural blocks with five to eight close-packed atomic planes, forming various polytypes with different numbers of the close-packed atomic planes in the structural blocks and with different stacking of the structural blocks. In the absence of the in-plane long-range ordering of the constituent atoms (as usually assumed in most studies in Mg-TM-RE LPSO phases), polytypes expressed as 10\(H\), 14\(H\), 18\(R\) and 24\(R\) polytypes are reported to form, among which 14\(H\) and 18\(R\) polytypes are the most dominantly observed ones. However, the details of the crystal structure are still controversial. We have very recently investigated the crystal structure of the 18\(R\)-type LPSO phase newly found in the Mg-Al-Gd system by scanning transmission electron microscopy (STEM) and transmission electron microscopy (TEM) and successfully determined the in-plane arrangement of the enriched layers [1,2]. The 18\(R\)-type Mg-Al-Gd LPSO phase is composed of 6-layer structural blocks with fully-ordered atomic arrangement. The enrichment of RE (and TM) atoms occurs in four consecutive close-packed atomic planes in each structural block and the long-range atomic ordering involving a periodic arrangement of Al\(_6\)Gd\(_8\) clusters of the L\(_{12}\) type occurs in the four consecutive atomic planes (Figs. 1 and 2). However, it should be noteworthy that the stacking sequence of the 6-layer structural blocks does not exhibit any long-range order along the stacking direction (Fig. 3). Because of these characteristics, the LPSO phase in the Mg-Al-Gd system cannot be described as an ‘LPSO’ phase any longer in a strict sense but as an order-disorder (OD) intermetallic phase with a so-called OD structure [1-3]. In the presentation, we will present the details of the crystal structure of the OD/LPSO phases in Mg-TM-RE alloys on the basis of the OD theory. Deformation behavior of the OD/LPSO intermetallic phases will also be presented.

References

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Fig. 1: Atomic resolution HAADF-STEM images of the Mg-Al-Gd OD phase.

Fig. 2: Periodic arrangement of AlGd clusters with the L1₂-type atomic arrangement in the 6-layer structural block projected along [0001].

Fig. 3: Variation of the stacking sequence of the 6-layer structural blocks.