In-situ observation for Mg-Cd-Yb quasicrystals re-precipitated in Mg matrix

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Mg alloys are the lightest in the structural materials. Their advantages reduce the transportation cost in the fields of such as airplanes, trains, cars, PC. Precipitations of the other phase for Mg are well known as one of the strengthening methods. Quasicrystals (Qc) show non-translational symmetry and five or ten-fold rotational symmetry forbidden in traditional crystallography [1]. These precipitation effects have been studied in the Mg-Zn-Y [2], Mg-Zn-Zr [3], Mg-Cd-Yb [4] systems. Especially, in the Mg-Cd-Yb system, large compositional region of Qc phase and wide binary region of Qc and α-Mg phase could help to reveal their significant features: their eutectic reaction, stable interfaces, unique orientation relationships [4, 5]. Recently, the annealing process after the solid-solution treatment could reduce the eutectic structure of Qc and α-Mg, generate the precipitation of faceted Qc particles and their twinning in Mg matrix. The excellent matching of Qc {2-f}/ Mg (0002) interface has been observed with high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) [6]. In this study, in-situ observation have been performed for precipitation of faceted Qc particles and twinning, their process would be discussed.

Mg-Cd-Yb alloys synthesized with an induction furnace have been annealed at 460~520ºC for 1~6 hours and subsequently quenched into water as solid-solution treatment. Annealing for precipitation of faceted Qc particles have been conducted below 300ºC. In-situ observation have been performed with TEM (JEOL JEM-2000EXII equipped with GATAN heating unit).

In-situ observation of annealing at 300ºC for $Mg_{95}Cd_{4.5}Yb_{0.5}$ alloy, re-precipitations of Qc started after annealing for 30 min and have grown to faceted 200 nm in size for 1 hour, 500 nm for 2 hours. Annealing at 240ºC, re-precipitation was confirmed in the field of view: same as electron beam radiated area, although few precipitates were observed in the other region. The influence of electron beam seemed to be large and non-negligible for this phenomenon. Combined the shape of Qc precipitates and orientation relationships to their surrounding Mg matrix, more stable interfaces: such as Qc{2-f}/Mg (0002), Qc{2-f}/Mg{10-10}, formed facets during annealing process. Sometimes, small Qc particles grew into single grain during in-situ observation, the twinning of Qc could be considered as the united Qc particles which possess same orientation in Mg matrix.

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