Self-Assembly of Two Unit Cells into a Nanodomain structure Containing Five-Fold Symmetry

Supporting Information

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Materials and Methods

The alloy with nominal composition of Mg-6.0 wt.% Zn (Mg-2.3 at.% Zn) was prepared by melting the pure Mg (99.9 wt.%) and Zn (99.9 wt.%) in the induction furnace with protection of the argon atmosphere. The molten alloy was stirred and kept at 760 ºC for 5 minutes and poured into a steel mold preheated to 300 ºC. The chemical composition of the obtained as-cast ingot was measured by OPTIMA 4300 DV composition analyzer, and the actual composition was Mg-5.87 wt.% Zn. The as-cast samples were solution treated at 400 ºC for 12 h, followed by water quenching and ageing in oil bath at 200 ºC for different times. Vickers hardness testing was performed by using a hardness tester (W-W-450SVD) with a loading force of 30 N and dwell time of 15 s. The TEM specimens with a diameter of 3 mm were ion-milled with Gatan 695, (5.0 kV ion gun energy under 10° milling angle, subsequently, 3.0 kV ion gun energy under 3.5° milling angle). Afterwards Gatan SOLARUS (950) Plasma Cleaning System was used to clean up the sample surface. TEM and STEM observation were then carried out using the JEM-ARM200F at an accelerating voltage of 200 kV, equipped with probe Cs corrector and cold field emission gun.

Supplementary Figures

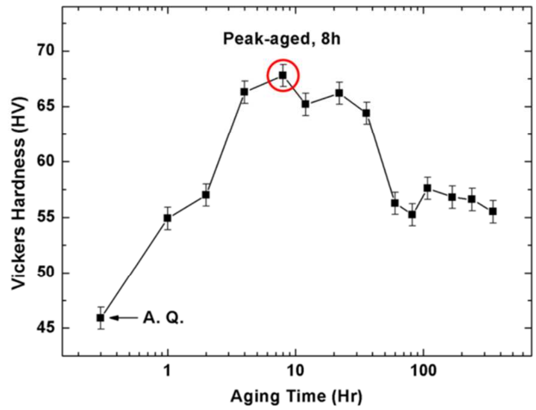

Fig. S1. Age hardening response curve of the Mg-6Zn alloy during isothermal ageing at 200 ºC. These samples were found to have the hardness maximum recorded around 8h, the hardness of the alloy increased from 45.6 to 64.4 Vickers hardness (HV), and subsequently decreased with prolonged aging. On the basis of this result, the peak-aged sample (8 h) was selected for the following TEM characterization.

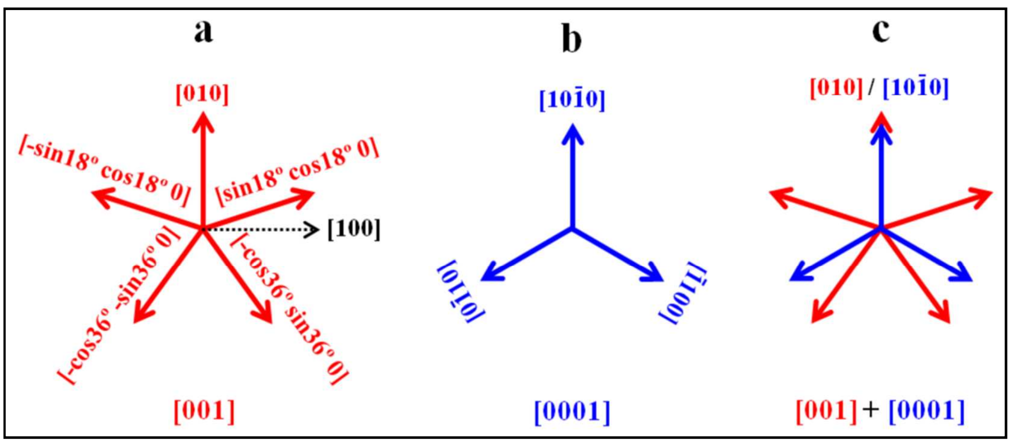

Fig. S2. Schematic diagram of orientation coordinates. (a) Orientation coordinate of the 2D five-fold nanodomain structure, viewed along $[001]_P$ zone axis (five-fold axis). (b) Orientation coordinate of the α-Mg matrix, viewed along $[0001]_\alpha$ zone axis. (c) Actual orientation coordinate between the nanodomain structure and α-Mg matrix, and it can be determined the orientation relationship is such that $(100)_P$ // $(1\bar{2}10)_\alpha$ and $[001]_P$ // $[0001]_\alpha$.

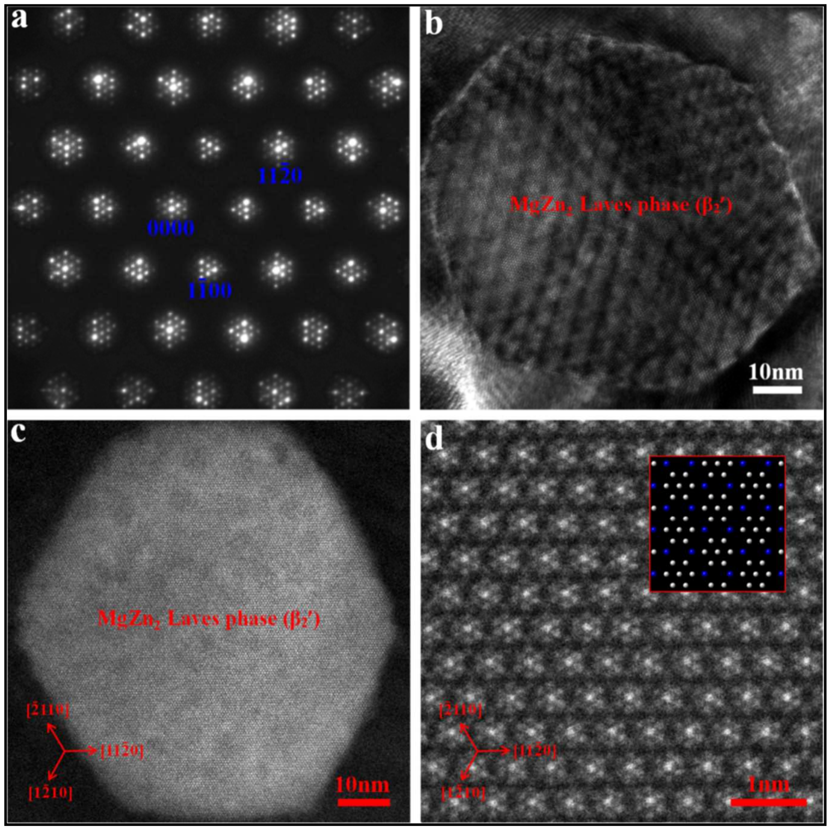

Fig. S3. TEM images of the $MgZn_2$ Laves phase (β_2') transformed from the 2D five-fold nanodomain structure in the Mg-6Zn alloy after isothermally aged at 200 ºC for 82 h. (a) Selected-area electron diffraction (SAED) pattern of a $MgZn_2$ Laves phase. (b) The corresponding high-resolution TEM image of Fig. S3a. (c) HAADF-STEM image of a $MgZn_2$ Laves phase. (d) Atomic-scale HAADF-STEM image of the $MgZn_2$ Laves phase, the inset is the corresponding modeled atomic arrangement. The electron beam is parallel to $[0001]_{\alpha}$ / $[0001]_{MgZn2}$.