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Martensitic Transformation of $N_{2.18}Mn_{0.82}Ga$ Single Crystal (II)

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Introduction

To analyze precisely the process of martensitic transformation, a synchrotron radiation white X-ray diffraction of the $Ni_{2.18}Mn_{0.82}Ga$ single crystal was performed by changing the temperature. It was possible to determine the mutual relationship between the various crystal planes of coexistent crystal structures.

Experimental

The SEM image of the single crystal used for the experiment is shown in Fig.1. The length of the crystal was about 6 mm.

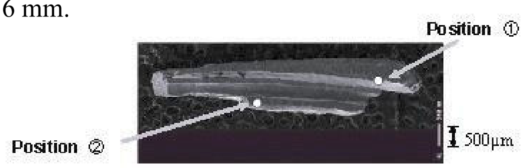

Fig. 1. SEM image of the single crystal. White circles are the areas irradiated by X-ray.

The beam line, BL-4B1, was used. The beam size of white X-ray was about 40µm at two irradiated sample positions. The sample was located in a small furnace for changing the temperature, and was surrounded by an IP with cylindrical shape of 10 cm diameter.

Results and Discussion

The Laue patterns from position ② in Fig. 1 for representative temperatures are shown in Fig. 2. For the analysis of the IP images the lattice constants of each coexistent crystal structure were used, which were previously determined by the powder neutron diffraction [1]. At 299.8 K before increasing the temperature, the crystal shows a tetragonal structure, the b-axis of which is parallel to the direction of crystal growth. At 400 K after heating, the crystal transforms to a cubic structure, the b-axis of which is also parallel to the direction of crystal growth. At 330 K during the cooling process, the cubic structure still remains. However, there appear three new different tetragonal structures, the lattice constants of which are the same as those at 299.8 K. One of the newly appeared tetragonal [010] zone axes is on the original cubic [010] zone axis. On this tetragonal [010] zone axis, we see the tetragonal (100) spot. The other two tetragonal [010] zone axes are on both sides of cubic [010] zone axis. On these two tetragonal [010] zone axes, there exists each tetragonal (001) point. We found that these tetragonal a- or c-axes are tilted a few degrees from the original cubic a-axis. With a further decrease in temperature, three tetragonal [010] zone axes approach each other. Finally at 103 K

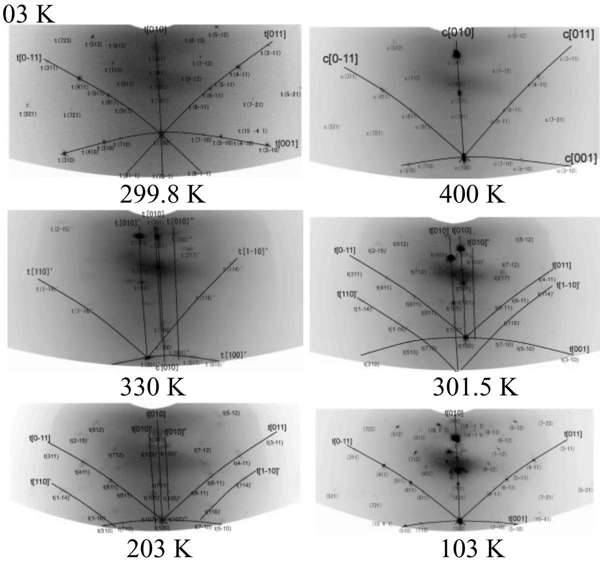

Fig. 2. Laue patterns from the measured position ②, at each temperature.

three tetragonal structures unite to form one tetragonal structure. The position of the [010] zone axis of this final one is nearly the same as that at 299.8K before increasing temperature. This will be the equilibrium state of tetragonal structure.

The schematic diagram showing the transformation process of unit cells is illustrated in Fig. 3, where the <111> axes do not move during the transformation [2].

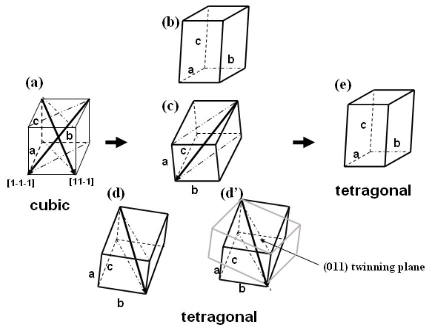

Fig. 3. (a) Cubic structure at 400 K. (b), (c), (d) and (d') tetragonal variants in the martensitic phase in the process of transformation. (e) tetragonal structure in the final equilibrium state at 103 K.

References

[1] K. Inoue et al., Materials Science Forum 426-432, 2261 (2003).
[2] K. Inoue et al., to be published in Mater. Trans. 46 No.6 (2005).

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