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Precursor behavior in structure factors of AuCd alloy observed by different wavelength X-ray

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Abstract

X-ray diffraction intensities from single crystals of $Au_{50.5}Cd_{49.5}$ alloy have been measured at various temperatures above the martensitic transformation into ζ'_2 phase. With the CuKα radiation, the diffraction intensities decrease sharply with decreasing temperature toward the transformation temperature, while no such decrease is observed with MoKα radiation. Those observations suggest precursor behavior occurring in surface regions.

Keywords: X-ray diffraction; Absorption coefficient; AuCd alloy; Martensitic transformation; Precursor phenomenon

1. Introduction

The martensitic transformation is known to be a displacive phase transformation and to be a typical first-order transformation. The macroscopic characteristics of the martensitic transformation are described well by the phenomenological theory [1–4]. The phenomenological theory of martensite was derived by assuming undistorted and unrotated plane called habit plane. The theory requires lattice parameters of parent and martensite phases, lattice correspondence between them and lattice invariant shear. By using these information, the theory can explain the habit plane, shape strain, orientation relation between the martensite and the parent phase. However, the phenomenological theory does not explain the microscopic mechanism of transformation. Therefore, the mechanism of the transformation from microscopic point of view has not been completed yet. Studies of the so-called precursor phenomena are one of the important ways to investigate the microscopic mechanism of the transformation.

Displacive and cooperative movements of atoms lead to attractive picture of the transformation, i.e. phonon softening. Neutron inelastic scattering experiment is the best way for observing dynamical aspect of the transformation. Although phonon behavior in the parent phase have been measured for several alloys, they are not always consistent with the structure of martensite [5–9]. In some cases phonon softening occurs at a reciprocal position that does not correspond to the structure of martensite, and in most cases phonon softening occurs incompletely. Static approach to the mechanism of transformation has been performed by X-ray diffraction and electron microscopy. Non-periodic diffraction patterns were reported as a precursor phenomenon for TiNi and AuCd alloys by X-ray diffraction [10,11]. Electron microscopy studies were also performed and tweed structures, which was understood to be a precursor phenomenon, were reported [12,13]. Nucleation-and-growth is also an important theme for the investigation of martensitic transformation. It must be closely related to the microscopic mechanism of the transformation.

AuCd alloy is typical alloy, which shows a martensitic transformation. Close to equi-atomic composition, there are two distinct martensitic phases called γ'_2 and ζ'_2, both of which transform from the B2 (CsCl) parent phase. γ'_2 Phase takes an orthorhombic structure, which

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