XANES study of mechanically alloyed Y_2Ni

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Mechanical alloying is a new method to make amorphous materials from mixed crystalline powders in a solid state diffusion reaction. The reaction is stimulated as milling time increases. Therefore the method is applicable to investigating time dependence of phase transformation to amorphous states.

We have measured XANES spectra of mechanically alloyed Y_2Ni in order to investigate the change in electronic state of individual elements such as Ni and Y atoms in the process of phase transformation from crystalline to amorphous states. The starting materials were crystalline Ni and Y metallic powders in the purity of 3N, the diameter of which were about 50 μm for Ni and about 800 μm for Y. They were milled in a stainless steel vessel with stainless steel balls in an argon atmosphere. XANES measurements were carried out at 300 K in the transmission mode near the K edge of Ni and Y using a Si(111) monochromator at the BL01B1 station of SPring-8. A Rh coated mirror was used to eliminate the higher harmonics.

X-ray diffraction shows that the intensity of reflections from Y and Ni crystalline planes decreases with increasing the milling time and that no significant reflection but the broad bump is detected after 60 hour milling. This means that the sample milled for 60 hours is in the amorphous state. Figure 1 represents XANES spectra in various milling time (indicated in parentheses) near the K edge of Ni. Each spectrum is normalized by subtracting the fit of the data points before the edge to the Victoreen polynomials and dividing the difference by the edge jump. With increasing the milling time a main peak (denoted by an arrow on the right hand side) decreases slightly, while a pre-peak (denoted by an arrow on the left hand side) increases sharply. The main peak is assigned to the allowed dipole transition from 1s to 4p states. We regard the pre-peak as the transition from 1s to 3d states mixed with 4p. It is noted that the spectrum after 60 hour milling has a resemblance to that of amorphous $Y_{67}Ni_{33}$ ribbons made by the melt spinning technique. As shown in Fig.2, the pre-peak shifts to lower energy side with increasing the milling time and appears to approach to a constant after the milling time of 50 hours. We have detected that XANES at Y K edge has no remarkable change by mechanical alloying till 30 hours. The features shown in Figs. 1 and 2 may come from the change in the Ni-Ni distance by mechanical alloying. Therefore we need EXAFS measurements to determine the distance of each atom and reveal these features of electronic states of Ni.

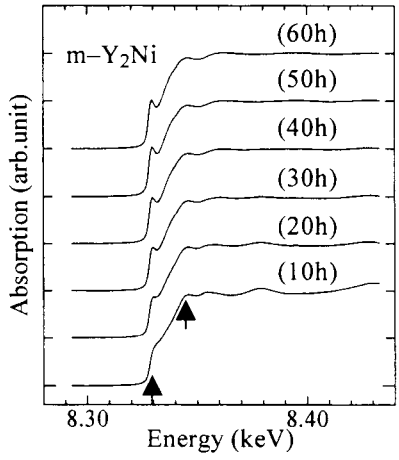

Fig. 1. XANES spectra of mechanically alloyed Y_2Fe. The milling time is denoted in the parenthesis.

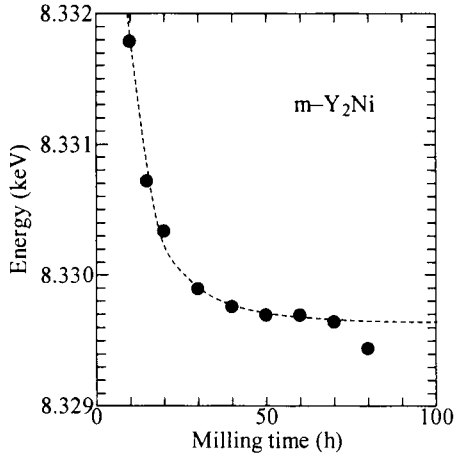

Fig. 2. The energy of pre-peak vs the milling time for mechanically alloyed Y_2Ni.