The Mössbauer Effect in Fe_3Sn_2

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In iron-tin alloys, the following intermetallic compounds have been reported to exist[1]: Fe_3Sn, Fe_2Sn, Fe_3Sn_2, FeSn and $FeSn_2$. Studies of the Mössbauer effect in these compounds, except for Fe_3Sn_2, have been performed by a number of workers,[2-6] because both constituents involve suitable nuclei.

Fe_3Sn_2 was shown to have a monoclinic structure with 40 atoms per unit cell and $a=13.5$Å, $b=5.34$Å, $c=9.20$Å, $\beta=103°$.[1] The Mössbauer parameters of both ^{57}Fe and ^{119}Sn nuclei in Fe_3Sn_2 are reported in this note.

Experimental

The alloy Fe_3Sn_2 was prepared by means of a sintering method. The powders of iron and tin were mixed in the stoichiometric proportion, pressed into a pellet, sealed in an evacuated quartz tube which was then heated at 800°C for a week and subsequently quenched in water. The phases which existed in the sample were identified as Fe_3Sn, Fe_3Sn_2 and β-Sn by X-ray diffractometry.

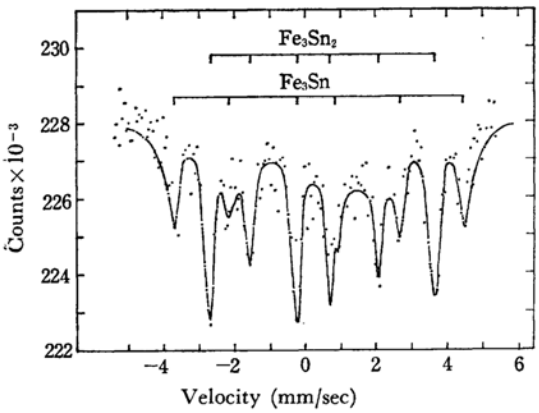

Fig. 1. Mössbauer absorption spectrum of ^{57}Fe in Fe_3Sn_2 at 24°C. The scale of the abscissa was taken toward ^{57}Fe in pure iron.

The ^{57}Fe Mössbauer spectrum of the sample at room temperature (source: ^{57}Co on Pd) is shown in Fig. 1. The spectrum shows the superimposed spectra of Fe_3Sn and Fe_3Sn_2. Table 1 gives the values of the relative velocity v of the source at which the maximum γ-ray absorption is observed for Fe_3Sn_2.

TABLE 1. THE RELATIVE VELOCITIES AND CORRESPONDING HYPERFINE COMPONENTS OF THE ABSORPTION LINE OBTAINED WITH THE SOURCE OF ^{57}Fe IN Pd AND Fe_3Sn_2 ABSORBER

hfs component	Transition	v, mm/sec
1	$+\frac{1}{2} \rightarrow +\frac{3}{2}$	-2.67 ± 0.03
2	$+\frac{1}{2} \rightarrow +\frac{1}{2}$	-1.55 ± 0.03
3	$+\frac{1}{2} \rightarrow -\frac{1}{2}$	-0.27 ± 0.03
4	$-\frac{1}{2} \rightarrow +\frac{1}{2}$	-0.69 ± 0.03
5	$-\frac{1}{2} \rightarrow -\frac{1}{2}$	2.08 ± 0.03
6	$-\frac{1}{2} \rightarrow -\frac{3}{2}$	3.63 ± 0.03

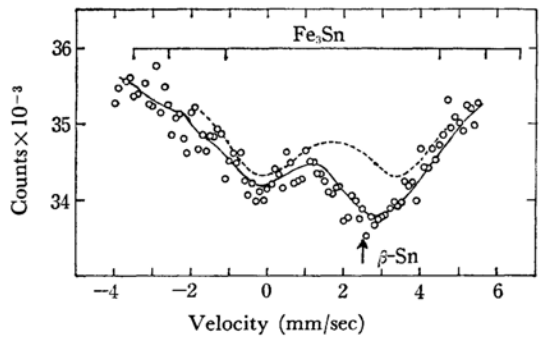

Fig. 2. Mössbauer absorption spectrum of ^{119}Sn in Fe_3Sn_2 at 24°C.

From the data in Table 1 the Mössbauer parameters of ^{57}Fe in Fe_3Sn_2 can be estimated as follows: isomer shift, $\delta=0.37\pm0.01$ mm/sec (relative to pure iron); quadrupole splitting, $2\varepsilon=0.21\pm0.02$ mm/sec; internal magnetic field, $H_i=196\pm3$ kOe; magnetic splitting of the ground level, $\alpha=2.30\pm0.03$ mm/sec; and magnetic splitting of the excited level, $\beta=1.33\pm0.03$ mm/sec. The ratio $\alpha/\beta=1.72\pm0.04$ is in good agreement with the value reported by Nikolaev *et al.*[4] for $FeSn_2$ and also with that by Kistner and Sunyar[7] for Fe_2O_3.

1) M. Hansen, "Constitution of Binary Alloys," McGraw-Hill Book Co., New York, N. Y. (1958).
2) C. Djega-Mariadassou, P. Lecocq, G. Trumpy, J. Täff and P. Cstergaard, *Nuovo Cimento*, **46B**, 35 (1966).
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4) V. I. Nikolaev, Yu. I. Shcherbina and S. S. Yakimov, *Soviet Phys. JETP*, **18**, 878 (1964).
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Figure 2 shows the ^{119}Sn Mössbauer spectrum of the sample at room temperature for 23.8 keV γ-ray against the $^{119m}SnO_2$ source. This spectrum also shows the superimposed spectra of Fe_3Sn, β-Sn and Fe_3Sn_2. The two peaks in the center of the spectrum are thought to be due mainly to β-Sn and Fe_3Sn_2, because the absorption peaks of Fe_3Sn are situated far from the center. Then, the ^{119}Sn Mössbauer spectrum of Fe_3Sn_2 can be obtained by subtracting the β-Sn absorption from the peak. The resulting spectrum is shown by the dotted line in Fig. 2. In this case, the spectrum cannot be resolved into its hyperfine structure. However, the value of the internal magnetic field can be estimated to be about 38 kOe by using together values for the magnetic moment of -1.0411 ± 0.002 nm for the ground state and $+0.672\pm0.025$ nm for the first excited state of ^{119}Sn obtained by Kistner.[6] The isomer shift δ is found to be about 1.7 mm/sec.

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