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# MÖSSBAUER STUDY OF TIN IN α-$Fe_2O_3$

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Natural tin was introduced into the crystal lattice of α-$Fe_2O_3$ by diffusion at 1000 °C. The $^{119}$Sn Mössbauer spectra of a well-resolved six-line due to supertransferred hyperfine magnetic field were obtained. It is insured that 2.7 mol% of natural tin was incorporated uniformly in the crystal lattice of α-$Fe_2O_3$. The Mössbauer parameters coincided with the values of the other works.

The behavior of foreign atoms in the crystal lattice has been studied by Mössbauer spectroscopy. Valuable informations on the locations of the foreign atoms, their charge state, the possibility of various associates, and dynamic features of the local environment were obtained from the Mössbauer spectra of the foreign atoms. The Mössbauer effect of small amounts of tin and iron in alkali halides and silver halides have been reported so far.[1,2] Fabrichnyi et al. have reported the Mössbauer effect of 0.7 mol% of 88% enriched $^{119}$Sn incorporated in α-$Fe_2O_3$ by means of coprecipitation with iron(III) hydroxide and annealing at an elevated temperature.[3,4] In these studies, the uniform incorporation of the foreign atoms in the crystal lattice is decisive of the success.

In this study, natural tin was introduced into the existing powder crystals of α-$Fe_2O_3$ by diffusion in an evacuated ampule at 1000 °C and Mössbauer spectra were measured for the purposes to insure the uniform incorporation of tin and to obtain reliable informations on the amounts of tin incorporated and the existing state of tin in the host matrix.

Freshly prepared anhydrous tin(II) chloride ($8.4\times10^{-5}$ mol) was dissolved in dry ethanol (20 $cm^3$). Powders of α-$Fe_2O_3$ (500 mg) were added to the solution. The powders were prepared by dissolving iron powders (GR, Katayama Kagaku Kogyo Co. Ltd.) in concentrated $HNO_3$ according to the literature.[5] The product was pulverized to fine powders with an agate vibrating mixer mill and passed through a 250 mesh sieve. Three times as much $NaBH_4$ as $SnCl_2$ was added to the solution at 3 °C under nitrogen atmosphere while the solution was stirred by means of ultrasonic waves to suspend the powders in the solution and to promote the reduction reaction. The tin reduced was deposited on the surface of the powder particles. The powders were filtered out of the suspension and washed with deaerated water several times to remove the reaction products throughly, then with ethanol and diethyl ether. The sample powders in an evacuated qualtz ampule were annealed at 1000 °C for 5 h and quenched to room temperature.

The Mössbauer spectra were recorded using a constant acceleration type

spectrometer with an accuracy within 0.05 mm $s^{-1}$. The γ-ray source of calcium stannate was used at room temperature and the absorber was at room temperature or cooled at 93 K in a liquid nitrogen cryostat. The isomer shift are reported relative to $BaSnO_3$. Mössbauer parameters were deduced from Lorentzian curves computer-fitted to the spectra by a least-squares method.

The Mössbauer absorption spectra of the tin deposited on the surface of the α-$Fe_2O_3$ powders and the heat treated samples are shown in Fig. 1. The value of the isomer shift of the deposited tin, 2.60 mm $s^{-1}$, coincided with the value of the bulk β-tin. Annealing at 1000 °C produced a well-resolved six-line due to the supertransferred hyperfine magnetic fields as shown in Fig. 1. The values of the isomer shift were 0.017 mm $s^{-1}$ at 20 °C and 0.111 mm $s^{-1}$ at 93 K corresponding to $Sn^{4+}$. The values of supertransferred hyperfine magnetic field of 123 kOe (1 Oe= $1000/4\pi$ A $m^{-1}$) at 20 °C and 131 kOe at 93 K agreed with the values of the other works using enriched tin[3] or emission spectroscopy.[6]

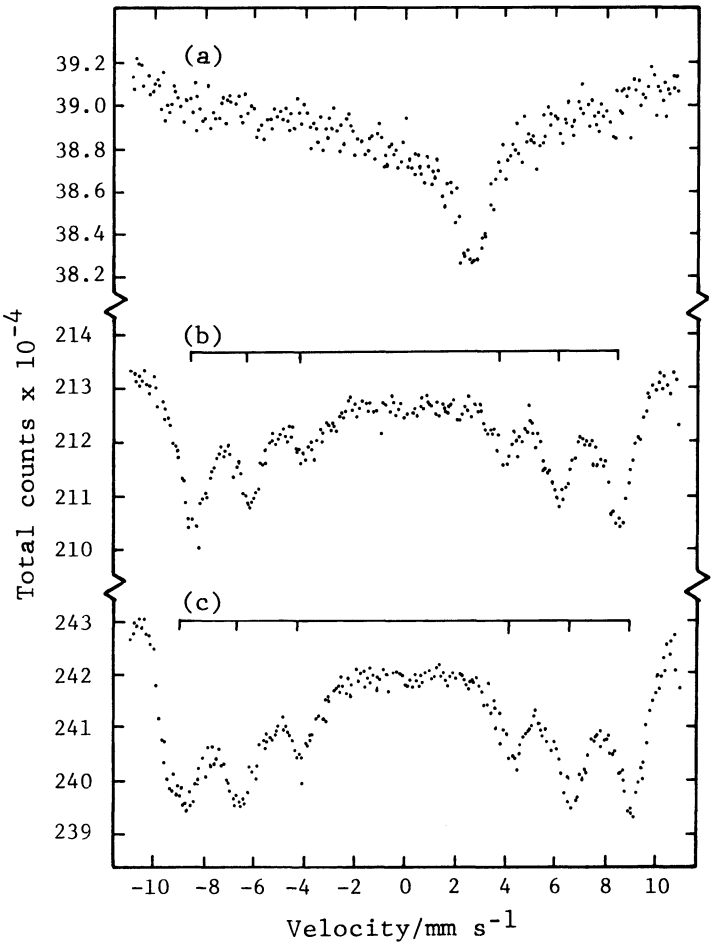


Fig. 1. Mössbauer spectra of $^{119}Sn$ deposited on the surface of the α-$Fe_2O_3$ powders recorded at 20 °C (a), and recorded at 20 °C (b) and 93 K (c) after annealed at 1000 °C.

References

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