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<td>Author(s)</td>
<td>IWAMOTO, Nobuya; MAKINO, Yukio; MIKAMI, Hirosuke</td>
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<tr>
<td>Citation</td>
<td>Transactions of JWRI. 11(2) P.165-P.166</td>
</tr>
<tr>
<td>Issue Date</td>
<td>1982-12</td>
</tr>
<tr>
<td>Text Version</td>
<td>publisher</td>
</tr>
<tr>
<td>URL</td>
<td><a href="http://hdl.handle.net/11094/10398">http://hdl.handle.net/11094/10398</a></td>
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<td>DOI</td>
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ESR spectra of Fe$^{3+}$ Ions in lead silicate slags

Nobuya Iwamoto*, Yukio Makino** and Hiroosuke Mikami***

KEY WORDS (Electron Spin Resonance) (Lead Silicate) (State Analysis) (Fe$^{3+}$ Ion)

Lead silicate glass has been widely investigated by various spectroscopic methods in order to elucidate the structure of silicate glass and its melt. On the other hand, the clarification of state of iron in slags is very important in iron- and steel-making and in some welding processes using fluxes. In this study, state of ferric ions in lead silicate glasses was investigated by electron spin resonance (ESR) spectroscopy.

Reagent grade SiO$_2$, PbO and Fe$_2$O$_3$ were used for preparing glass specimens. The mixtures of these reagents were melted in platinum crucibles at the temperatures 100°C higher than their liquidus temperatures in an electric furnace. Fe$_2$O$_3$ addition was fixed to be 0.5mol% in every glass. After being held for 1 hr in air, they were cooled. ESR spectra were measured with X-band method using a spectrometer of Varian E-109 type. Relative quantity of Fe$^{3+}$ ions related to each resonance was approximately estimated by I($\Delta H$)$^2$, where I and $\Delta H$ are the peak-to-peak height and width of the resonance.

ESR spectra of Fe$^{3+}$ ions in lead silicate glasses are shown in Fig. 1. Two resonances are observed near g=2.0 (H=3400 G) and g=4.3 (H=1600 G), respectively. A shoulder is observed near g=6.0 (H=1050 G). According to the previous papers, the g =4.3 and g=6.0 resonances arise from Fe$^{3+}$ ions in a rhombic and axial crystal fields, respectively. The g=2.0 resonance can arise from two sorts of origins, that is, from dipole-dipole interacted Fe$^{3+}$ ions and Fe$^{3+}$ ions in an axial crystal field. Further, it is indicated that the g=2.0 resonance due to dipole-dipole interaction between Fe$^{3+}$ ions begins to be observed at the content of Fe$_2$O$_3$ more than 1 mol%. As shown in Fig.1, the intensity of the shoulder near g=6.0 has a tendency to increase with increasing the intensity of the g=2.0 resonance. Accordingly, it is reasonable to assign the g=2.0 resonance not to dipole-dipole interacted Fe$^{3+}$ ions but to Fe$^{3+}$ ions in an axial crystal field. Figure 2 shows the composition depend-

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Transactions of JWRI is published by Welding Research Institute of Osaka University, Ibaraki, Osaka, Japan

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Fig. 2 Dependences of relative quantities, \( r_{g=2.0} \) and \( r_{g=4.3} \) upon PbO content.

The relation between state of Fe\(^{3+}\) ion and silicate structure will be investigated in near future.

References