51. Cathode-ray Investigation of the Corrosion of Iron.

(I) Corrosion of Cast Iron.

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(Comm. by S. NISHIKAWA, M.I.A., June 12, 1945.)

The corrosion of pure iron was investigated by means of cathode-rays by Miyake.¹⁾ According to his result, the brown rust formed on an iron specimen immersed in water is $\gamma\text{-Fe}_2\text{O}_3\cdot\text{H}_2\text{O}$ and the surface deprived of the brown rust is covered by a thin layer, the substance of which is found to be the so-called "two ring substance (T.R.S.)" for a short immersion, but changes to $\gamma\text{-Fe}_2\text{O}_3$, and finally to a composite mixture, as the period of immersion is increased. The "two ring substance" is a corrosion product discovered by Miyake, and is inferred to be an intermediate compound between $\gamma\text{-Fe}_2\text{O}_3\cdot\text{H}_2\text{O}$ and $\gamma\text{-Fe}_2\text{O}_3$. In the present experiment a similar investigation was carried out with cast iron, which gave a result distinctly different from the case of pure iron.

The test pieces used in this experiment were small discs of cast iron 4 mm in diameter and their surfaces were ground with coarse emery cloth. They were immersed in an aqueous 1% NaCl solution at a room temperature of 5° to 25°C. After a certain period of immersion they were taken out from the solution and washed vigorously with a water jet to remove the brown rust formed on the surface. About 15 specimens thus prepared, whose periods of immersion varied from 0.5 to 100 hours were examined by cathode-ray diffraction.

The Debye-Scherrer rings due to them are classified into two types; one of them is "T.R.S." while the other is unknown either in cathode-ray or X-ray analysis. The latter consists of very sharp rings, so it shall be denoted by "sharp ring substance (S.R.S.)" for convenience. The frequency of appearance of both types has no correlation with the period of immersion, and they appeared simultaneously in many cases. The observed values of ring spacings and intensities of "S.R.S." are tabulated in Table I. These values coincide well with those calculated on the assumption that "S.R.S." belongs to the orthorhombic system with $a=5.305$ Å, $b=3.160$ Å and $c=7.834$ Å. The indices determined on this assumption are shown in the fourth column of the table. In some cases, especially when the specimen is prepared at low temperatures, the intensity of "S.R.S." is very anomalous,—as shown in the last

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(1) S. Miyake: Sc. Pap. I.P.C.R., **36** (1939), 363.

column of the table,—and the sharpness of rings is decreased. This substance is denoted by “S.R.S. (II)” for convenience; however this may be chemically identical with “S.R.S.”, although the ring intensity is modified by the fact that the crystal is very thin in the *c*-direction.

The substance “S.R.S.” was first observed in this experiment. However it is not clear whether it is peculiar to cast iron or not. To throw light on this point, several experiments were carried out with pure iron, the results of which are to be reported in the next paper.

Table I.

Ring	Intensity	$\frac{1}{d}$ obs. $\left(\frac{1}{\text{\AA}}\right)$	Index	$\frac{1}{d}$ calc. $\left(\frac{1}{\text{\AA}}\right)$	S.R.S. (II)
<i>A</i>	v. s.	0.377	(200)	0.377	s.
<i>B</i>	s.	0.428	(103)	0.426	w.
<i>c</i>	m.	0.510	(004)	0.510	v. w.
<i>d</i>	v. w.	0.574	(301)	0.580	—
<i>E</i>	v. s.	0.633	(020)	0.633	} s.
			(204)	0.634	
<i>F</i>	v. s.	0.648	(310)	0.648	} m.
<i>g</i>	m.	0.736	(220)	0.736	
<i>h</i>	m.	0.764	(123)	0.763	—
<i>i</i>	w.	0.813	(024)	0.814	—
<i>j</i>	w.	0.969	(130)	0.968	} m.
			(026)		
<i>k</i>	m.	0.994	(510)	0.993	
<i>l</i>	w.	1.030	(231)	1.029	—
<i>m</i>	w.	1.104	(330)	1.105	m.
<i>n</i>	v. w.	1.130	(600)	1.131	—
<i>o</i>	v. w.	1.273	(040)	1.266	—
<i>p</i>	v. w.	1.323	(240)	1.322	—
			(044)	1.324	

In conclusion, the authors express their sincere thanks to Professor S. Nishikawa for his encouragements and to Dr. S. Miyake for his kind advices.