

The data discussed above form part of an extensive programme designed to relate chemical and physical properties to intramolecular configuration and, as a sequel to the above discussion, we might add that the substances IV ($n = 1, 2$ and 3 respectively) are brominated much *less* readily than anisole, and that the chloro compounds V ($n = 1, 2$ and 3 respectively) are much *less* reactive than anisyl chloride. The significance of these surprising results will be discussed elsewhere.

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¹ Dewar, *Farad. Soc. Discussion*, **2**, 53 (1947).

² Unpublished work.

A New Intermetallic Phase in Alloy Steels

AN X-ray examination of a number of residues separated electrolytically from steels containing chromium, nickel and molybdenum has revealed the presence of a new constituent, which we designate ' χ '. The residues contained varying amounts of the σ -phase, the carbide $(Cr, Fe, Mo)_{23}C_6$, and χ itself. This new constituent does not appear to be a simple high- or low-temperature alternative form of the σ -phase itself, and its full significance is not yet established.

Chemical analysis of a residue which contained a large amount of the χ -constituent showed a closer similarity in chemical composition between it and the σ -phase than might have been expected, the most marked differences being in the nickel, molybdenum and silicon contents.

X-ray powder patterns with cobalt $K\alpha$ radiation, using a β -screen between the specimen and photograph, of σ - and χ -phases

σ -phase†		χ -phase (cubic $a_0 = 8.860$ kX.)			
Intensity	Inter-planar spacing	Intensity	Inter-planar spacing	N	hkl
	kX.		kX.		
vw	2.370	*vw	2.368	14	321
w	2.275	vw	2.215	16	400
s	2.128	s	2.088	18	330, 411
wm	2.067	*w	1.981	20	420
w	2.019	*w+	1.889	22	332
wm	1.969	*w-	1.809	24	422
s	1.928	w	1.738	26	510, 431
m	1.883	w	1.437	38	611, 532
vw	1.839	w	1.279	48	444
vw	1.603	w-	1.253	50	710, 550, 543
w	1.254	ms	1.206	54	721, 633, 552
w	1.236	w+	1.125	62	732, 651
w	1.219	*vw	1.091	66	811, 741, 554
w	1.205	*vw	1.074	68	820, 644
vw	1.196	m	1.044	72	822, 660
vw	1.164	w	1.030	74	831, 750, 743
vw	1.136	w-	1.003	78	752
wm	1.0647	(*vw)	0.9905	80	840
wm	1.0355	vw	0.9784	82	910, 833
vw	0.9976	vw	0.9444	88	664
vw	0.9880	m	0.9339	90	930, 851, 754
wm	0.9808				
vw	0.9429				

* These χ -lines were frequently overlapped by lines of other constituents.

† The σ -phase from which these interplanar spacings are derived was the main constituent in an alloy containing 46.9 per cent Fe, 44.9 per cent Cr, 8.2 per cent Ni. Slightly lower spacings apply to a σ -phase of composition near 3 per cent Ni, 40 per cent Cr and 57 per cent Fe. Higher spacings are obtained from σ -containing molybdenum in solid solution.

Debye-Scherrer powder photographs show that the χ -phase has a structure very similar to that of α -manganese. It is based on a body-centred cubic structure of spacing $a_0 = 8.860$ kX. Some samples have a slightly higher spacing indicating a varying solid solution content. Bradley and Goldschmidt¹ have suggested that there is a slight resemblance between the σ -phase itself and α -manganese, a point which has been discussed elsewhere². The σ -phase has, however, a sufficiently different crystal structure, is not cubic and can therefore be definitely distinguished from the χ -phase. The χ -phase has so far only been discovered in steels containing molybdenum and may thus be associated with the presence of that element (and possibly also tungsten). The powder patterns of the two phases are listed in the accompanying table. (The structure and unit cell of the σ -phase are not known.)

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¹ Bradley, A. J., and Goldschmidt, H. J., *J. Iron and Steel Inst.*, **144**, 273 (1941, ii).

² Andrews, K. W. *Research*, **1**, (10), 478 (1948).

Heating Metal Specimens in Corrosion Tests

DURING recent work in these Laboratories on the resistance of metals to boiling organic liquids, an investigation of various methods of heating has been carried out. We have found that much higher solution-rates are obtained when the heat of vaporization is supplied through the surface of the test piece than when the liquids are heated in the usual way by gas flames applied to the glass apparatus.

Through the courtesy of Messrs. Rediffusion, Ltd., we have been able to show that a convenient method of providing heat through the test piece is by induction heating. Reproduction of results is better than by gas heating, providing the heat flux is kept sufficiently high to ensure boiling over the whole area of the test piece.

Typical solution-rates, in milligrams per square decimetre per day, for mild steel are shown in the accompanying table, where the corrosive liquid is dehydrated crude tar acid.

Watts to anode of induction heater	Solution-rate (mgm./sq.dcm./day)	Reflux-rate (ml. per min.)
111	1,720	Just boiling
273	8,100	2.9
358	10,000	3.8
572	14,000	7.5
(Liquid heated by gas)	3,500	5

This method of corrosion testing gives promise of becoming a useful tool for assessing probabilities of corrosion in practice, especially where heat transfer through metal surfaces to corrosive liquids is involved.

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