Table 1. X-RAY DATA FOR IRON OXIDE – IRON CHROMITE SOLID SOLUTIONS OF COMPOSITION $FeFe_{(2-x)}Cr_xO_4$

| Composition $x$ | Cubic at 20° C. | | Tetragonal at – 180° C. | |
|---|---|---|---|---|
| | $a_0$ (A.) | $a_0$ (A.) | $c_0$ (A.) | $c/a$ |
| 1·0 | 8·396 | 8·384 | 8·392 | 1·001 |
| 1·2 | 8·405 | 8·369 | 8·410 | 1·005 |
| 2·0 | 8·377 (± 0·001) | 8·454 | 8·187 | 0·968 |

magnitude of this distortion has increased appreciably, as shown in Table 1.

The results obtained for the solid solutions led us to believe that with pure ferrous chromite, $FeCr_2O_4$, an even larger lattice dilatation effect might be obtained at liquid-air temperature. Examination disclosed that, although the tetragonal deformation was indeed larger in magnitude, there was a change in its sense. The tetragonality observed was the result of a relative contraction, instead of expansion, in one of the [001] directions, so that the axial ratio was less, not greater, than 1·0 (see Table 1).

It will clearly be of considerable interest to examine the low-temperature behaviour of compositions between $x = 1·2$ and $x = 2·0$. X-ray studies are now being carried out on several solid solutions lying in this range, and it is hoped to present all the results in detail elsewhere.

The mechanism by which the structure cell of spinel-type oxides of this type deforms from its room-temperature cubic symmetry on cooling through a certain critical temperature is not yet properly understood. It would appear likely, however, that the lattice dilatation effects are linked with alterations of the magnetic dipole alignments such as have been discussed by Li[7] in connexion with simple anti-ferromagnetic monoxides and other compounds. It is possible that an extension of Li's arguments on spontaneous magnetostriction to the spinel-type compounds will explain all the various structure changes that have been described above.

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## Ductility in Chromium

MUCH recent work has been carried out on the preparation and properties of pure chromium with the aim of establishing chromium base alloys as engineering materials. The obstacle to this, the room-temperature brittleness, has naturally attracted great attention. It has been suggested that the brittleness of chromium is promoted by nitrogen content above 20 p.p.m., by rough surface condition and by recrystallization. It had been found previously that the greatest lowering of the ductile/brittle transition temperature in chromium is obtained in polished pieces which have been worked below the recrystallization temperature. Complete recrystallization in rolled chromium raises the transition temperature so that there is usually no bend ductility at room temperature, although pieces in this condition showing ductility have been produced[1].

Recently, we have found that the main source of nitrogen in electrolytic chromium is the presence of nitrates in the electrolyte of a conventional hexavalent chromium bath and that nitrogen in other forms such as ammonia or air has no appreciable effect on the composition of the deposited metal.

We have also found that chromium produced by the lubricated extrusion of sheathed, compacted flakes can show ductile behaviour in bend tests, even though the nitrogen content is as high as 900 p.p.m. An electro-polished piece made in this way, and having an insoluble content of 1·25 per cent and a nitrogen content of 0·091 per cent, showed ductile bend behaviour at a temperature of – 30° C., but broke in a brittle manner at – 50° C. Charpy-type impact tests on a low-nitrogen piece of this extruded chromium gave results of 2·17 ft.lb. at room temperature and 5·74 ft.lb. at 250° C. using machined, unnotched specimens of 1 cm. square cross-section. These figures can be compared with corresponding values of 0·4 and 0·6 ft.lb. respectively for tests on similar-sized chromium bars made by sintering chromium powder in purified hydrogen. X-ray diffraction examination of the extruded chromium showed it to be in a fully recrystallized condition.

It therefore appears that the extrusion method indicated above has an effect of increasing ductility and lowering of the transition temperature which over-rides the opposing effect of nitrogen content and recrystallization. Clearly a measure of preferred orientation may be produced by the extrusion and this may be playing an important part in the effect. This is being investigated.

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## Application of the Schlieren Technique to the Study of Ripples

IN the simplest form of ripple tank demonstration, a 'point' source of light placed below the tank is used for casting 'shadows' of the ripples on a screen. The ripples have a complicated lens action on the light, so that the relation between the pattern of ripples on the water surface and the pattern of light and shade on the screen is not necessarily a simple one: caution must be exercised in interpreting the finer details of the pattern observed. In more complicated forms of the apparatus, a lens is used above the tank for projecting on to the screen a real image of the ripples; but the same difficulty arises. If the water surface is in sharp focus, the ripples are almost invisible. The lens must be raised so that it focuses the focal lines of light produced by the ripple crests. Now the distance of these focal lines above the surface of