summarized by Fersman and Goldschmidt (1911). As our sample did not allow any optical measurement, we have used X-ray methods. A rotation crystal photograph around the axis of the cyclic twin confirmed that this axis is a [110] direction; no powder ring was apparent. We recorded the (*hhl*) layer of the reciprocal space on the Rimsky retigraph, and obtained five superimposed rectangular lattices, with the following angles between [001] axes: 70°, 71°, 70°, 71°, 76° (the theorical value is 70°32′, and for the void, 7°20′). The void was not observed in our sample. The indices of diffraction spots are {004}, {111}, {220}, {113}, {331}, {224}, {333}, {440}, and {444}. The geometry of this twin in natural diamond is thus confirmed by X-ray methods (Fig. 2). It consists of five crystals united by contact in (111) twin position, all having a common [110] direction.

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American Mineralogist
Vol. 57, pp. 1873–1876 (1972)

CRYSTALLOGRAPHY OF A HIGH-TEMPERATURE PHASE OF REALGAR

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ABSTRACT

Synthetic high-temperature realgar has $a = 9.58$, $b = 9.67$, $c = 9.08$ Å, $\beta = 100°50'$, and space group $C2/c$ (or Cc).

Arsenic sulfides were crystallized at about 350°C, using basically the sublimation technique described by A. Schuller (1894). Among the crystalline products, small (less than 0.10 mm in diameter) tabular

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Table 1.

Indexed powder patterns of synthetic and natural high-temperature realgar.

hkl	synthetic		natural (Clark, 1970)	
	d	I	d	I
110, 011	6.71	20	6.74	10
$\bar{1}11$	5.68	100	5.72	70
111	5.05	80	4.96	60
020	4.84	20	4.86	20
200	4.71	5	4.65	10
021	4.15	10	4.18	20
$\bar{1}12$	3.93	30	3.91	40
112	3.48	5	3.41	10
220	3.37	5	3.37	5
022	3.28	5	3.30	10
130	3.13(5)	10	3.17	40
			3.07	40
221	3.01(9)	100	2.98	100
202, 310	2.98(3)	30	2.95	60
$\bar{2}22$, $\bar{1}13$	2.85(8)	100	2.88	80
131			2.81	30
$\bar{3}12$	2.74(2)	5	2.74	30
311			2.71	10
113, $\bar{1}32$	2.58(2)	5		
$\bar{2}23$	2.38(5)	5		
330, $\bar{3}31$	2.25(7)	10		
240, 204	2.16(4)	10		
420	2.11(9)	10		
$\bar{3}33$	1.92(0)	2		
151, 510	1.84(5)	2		
$\bar{2}43$	1.82(2)	2		
$\bar{4}04$, 115	1.79(1)	2		
$\bar{1}52$	1.75(9)	2		
060	1.61(2)	5		
600	1.55(8)	5		

Unit cell: $a = 9.58$ Å

$b = 9.67$ Å

$c = 9.08$ Å

$\beta = 100^{\circ}50'$

Space group: C2/c or Cc

crystals of orange-colored high-temperature realgar were found. The identity of these crystals was established by comparison of their X-ray powder diffraction pattern with those obtained by H. T. Hall (1966) and by A. H. Clark (1970), respectively, for synthetic and natural high-temperature or α-realgar.

The high-temperature realgar crystals exhibited monoclinic symmetry with large pinacoidal (001) and small prismatic (111) and $(1\bar{1}1)$ faces. Their specific gravity was measured with a Berman balance, using acetylene tetrabromide for liquid, and was found to be 3.46. Electron microprobe analysis of several crystals, using chemically pure metallic arsenic and selected natural sulfur, realgar, and orpiment for standards, gave the composition range of $As_{4.0-4.4}S_{4.0}$, which is in accordance with the analysis reported by A. H. Clark (1970).

Several orientations and levels of precession photographs were taken on two crystals, using Mo$K\alpha$ radiation. The unit cell dimensions calculated from these photographs were improved by the measurement of d-values of $h00$, $0k0$, $00l$, $hk0$, and $0kl$ reflections in the powder diffraction pattern of high-temperature realgar using an external silicon standard and Cu$K\alpha$ radiation. The unit cell dimensions obtained are $a = 9.58$, $b = 9.67$, $c = 9.08$ Å, and $\beta = 100°50'$. A more meaningful refinement of the lattice parameters could not be implemented due to the lack of back reflection lines and spots in the powder and Weissenberg photographs, respectively. The absence of high-angle diffractions may be explained by the probably large temperature factors of the atoms in these high-temperature crystals. The symmetry and systematic absences of the diffraction patterns indicate that the space group of high-temperature realgar is either $C2/c$ or Cc.

Using the above unit cell dimensions and the stoichiometric composition As_4S_4, the calculated density is 3.45 g/cm^3 and $Z \approx 4$. The powder pattern was indexed and is given in Table 1 along with the powder pattern of natural high-temperature realgar. Determination of the structure of this synthetic high-temperature realgar has been started.

ACKNOWLEDGMENTS

The authors are indebted to H. T. Hall and P. W. Weiblen for their help in synthesizing and analysing arsenic sulfide crystals and to the National Science Foundation for financial support.

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American Mineralogist
Vol. 57, pp. 1876–1880 (1972)

NEW OBSERVATIONS ON NATURAL PYRRHOTITES

Part II. Lamellar Magnetite in Monoclinic Pyrrhotite

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ABSTRACT

Monoclinic pyrrhotite from Norseman, Western Australia, has lamellae of submicrometer thickness, identified by microprobe and electron diffraction as magnetite. The lamella surface is (111) of magnetite parallel to (001) of pyrrhotite, corresponding to a close fit of close-packed planes of the two structures. The perfect lamellar nature of the magnetite in unaltered pyrrhotite indicates origin by exsolution, requiring solid solution of oxygen in earlier pyrrhotite.

It is generally assumed that iron oxides are insoluble in solid iron sulfides, and that all the oxygen present in the sulfide melt will crystallize as magnetite at the solidus (*e.g.*, Rosenqvist and Hynne, 1953). However, Naldrett (1969) observed a solid state reaction between magnetite and pyrrhotite, indicating some oxide solubility; and, as further evidence, we have observed a natural occurrence of extremely fine magnetite lamellae which are oriented parallel to the basal plane of monoclinic pyrrhotite in a drill core from Norseman in Western Australia.

The pyrrhotite was sectioned at a small angle to the basal plane, giving an effective magnification of the width of the lamellae. They are shown in Figure 1. Identification was difficult because of the extremely fine nature of the lamellae. However, one lamella expanded out into an area several micrometers wide (Fig. 1b), and this could be positively identified optically and by microprobe. In addition, a microprobe traverse across a lamella showed a qualitative dip in the sulfur/iron ratio as expected for magnetite. Titanium was not present.

We believe that the perfect lamellar nature of the magnetite in unaltered monoclinic pyrrhotite argues a primary exsolution origin,