JPEDAV (2004) 25:272
DOI: 10.1361/15477030419559
1547-7037/$19.00 ©ASM International

Ag-Fe-S (Silver-Iron-Sulfur)

V. Raghavan

The previous review of this system by [1988Rag] presented a liquidus surface, a reaction sequence, and three isothermal sections at 1200, 700, and 480 °C, based mainly on the work of Taylor [1968Tay, 1970Tay1, 1970Tay2]. Recently, [2000Bry] reinvestigated the Fe-$Fe_{1-x}S$-Ag_2S-Ag part of this ternary system.

Binary Systems

The Fe-Ag system is characterized by very low mutual solubility between Fe and Ag both in the liquid and the solid states. The Ag-S phase diagram [1986Sha] is characterized by the presence of two liquid miscibility gaps and two corresponding monotectic reactions at 906 and 742 °C. At 806 °C, the liquid that lies between the Ag-rich liquid and the S-rich liquid decomposes eutectically to (Ag) and Ag_2S. There are two intermediate phases in the Fe-S system [1982Kub]. The monosulfide pyrrhotite $Fe_{1-x}S$ (hexagonal NiAs type) is stable at Fe-deficient (S-rich) compositions with a range of 50-55 at.% S. $Fe_{1-x}S$ with 52 at.% S melts congruently at 1188 °C. In the Fe-FeS region, the solidification is through a eutectic reaction at 988 °C. In the FeS-S region, a monotectic reaction at 1082 °C yields $Fe_{1-x}S$ of 54.2 at.% S and a sulfur-rich liquid $(S)_l$. At 743 °C, cubic FeS_2 (pyrite) forms peritectically and undergoes a transition to orthorhombic FeS_2 (marcasite) at 425 °C.

Ternary Phase Equilibria

[2000Bry] used differential thermal analysis (DTA) and quantitative x-ray microanalysis to study the phase equilibria along three joins of this ternary system: Ag_2S-Fe, $Fe_{1-x}S$-Ag_2S, and $Fe_{1-x}S$-Ag. The $Fe_{1-x}S$-Ag_2S section was reported to be a pseudobinary system of the simple eutectic type. The eutectic temperature and composition were placed at 665 °C and 75 mol % of Ag_2S. This eutectic reaction combines with that in the Ag-S system at 806 °C and that along the $Fe_{1-x}S$-Ag join at ~950 °C to yield a ternary eutectic reaction $L \leftrightarrow (Fe_{1-x}S + Ag_2S + Ag)$ at 570 °C and at the liquid composition of 31Ag-10Fe-59S (at.%) [2000Bry].

The liquidus projection and the reaction table reviewed by [1988Rag] are based on the comprehensive work of Taylor [1968Tay, 1970Tay1, 1970Tay2]. No heat effect in DTA experiments around 665 °C (as observed by [2000Bry]) was reported by Taylor. A ternary eutectic reaction at 532 °C (see the reaction table in [1988Rag]) yields the product phases: $(Fe_{1-x}S + Ag_2S + FeS_2)$.

[2000Bry] investigated only a limited number of samples. The liquidus surface presented by them is incomplete and does not account for all the known binary invariant reactions. In view of this, pending further studies, no change is suggested to the liquidus projection and the reaction scheme reviewed by [1988Rag].

References

1968Tay: L.A. Taylor: "The System Silver-Iron-Sulfur: Phase Equilibria and Geologic Applications," Ph.D. Dissertation, Lehigh University, Bethlehem, PA, 1968, pp. 1-171.

1970Tay1: L.A. Taylor: "The System Ag-Fe-S: Phase Equilibria and Mineral Assemblages," *Mineral. Deposita,* 1970, *5*, pp. 41-58.

1970Tay2: L.A. Taylor: "The System Ag-Fe-S: Phase Relations Between 1200 and 700°C," *Metall. Trans.,* 1970, *1*, pp. 2523-29.

1982Kub: O. Kubaschewski: "Iron-Sulphur" in *Iron – Binary Phase Diagrams*, Springer-Verlag, Berlin, 1982, pp.125-28.

1986Sha: R.C. Sharma and Y.A. Chang: "The Ag-S (Silver-Sulfur) System," *Bull. Alloy Phase Diagrams*, 1986, *7*(3), pp. 263-69.

1988Rag: V. Raghavan: "The Ag-Fe-S (Silver-Iron-Sulphur) System," in *Phase Diagrams of Ternary Iron Alloys. Part 2,* Ind. Inst. Metals, Calcutta, India, 1988, pp. 10-23.

2000Bry: V.A. Bryukvin, N.M. Pavlyuchenko, L.I. Blokhina, and N.V. Blagoveshchenskaya: "Phase Equilibria in Composition Region Fe-$Fe_{1-x}S$-Ag_2S-Ag of Ag-Fe-S System," *Metally,* 2000, (3), pp. 45-48 (in Russian); TR: *Russ. Metall.*, 2000, (3), pp. 47-52.