JPEDAV (2010) 31:387–388
DOI: 10.1007/s11669-010-9722-8
1547-7037 ©ASM International

Fe-O-Sn-Zn (Iron-Oxygen-Tin-Zinc)

V. Raghavan

Recently, [2004Han] determined the isothermal equilibria in air at 1400 and 1300 °C of this quaternary system, as a first step towards understanding the phase equilibria of more complex slag systems containing in addition Cu and Pb.

Ternary Subsystems

Updates on the Fe-O-Sn and Fe-O-Zn appear in this issue. A pseudo-binary section in air along the SnO_2-ZnO join was determined by [2004Han] between 1400 and 1200 °C, as part of their investigation of this quaternary system. This section is shown in Fig. 1. The experimental procedures for this investigation are the same as described below for the quaternary system [2004Han]. About 1.5 mol.% of ZnO dissolves in cassiterite (SnO_2). The spinel phase Zn_2SnO_4 is stable and shows a homogeneity range of about 2 mol.% on the Zn-rich side. The solubility of SnO_2 in zincite (ZnO) is negligible.

Quaternary Phase Equilibria

The phase equilibria of this quaternary system were earlier studied by [1981Tys]. Starting with reagent grade powders of Fe_2O_3, SnO_2, and ZnO, [1981Tys] prepared mixtures, annealed them at 1060 °C for 150-300 h, followed by quenching in a flow of compressed air. The phases were identified by x-ray powder diffraction and the phase compositions were calculated by measuring the lattice parameters. The isothermal section constructed by [1981Tys] at 1060 °C on the Fe_2O_3-SnO_2-ZnO plane is shown in Fig. 2. A continuous cubic solid solution forms between $ZnFe_2O_4$ (inverse spinel) and Zn_2SnO_4 (normal spinel). The lattice parameter varies non-linearly from 0.8439 nm at $ZnFe_2O_4$ to 0.8660 nm at Zn_2SnO_4, showing

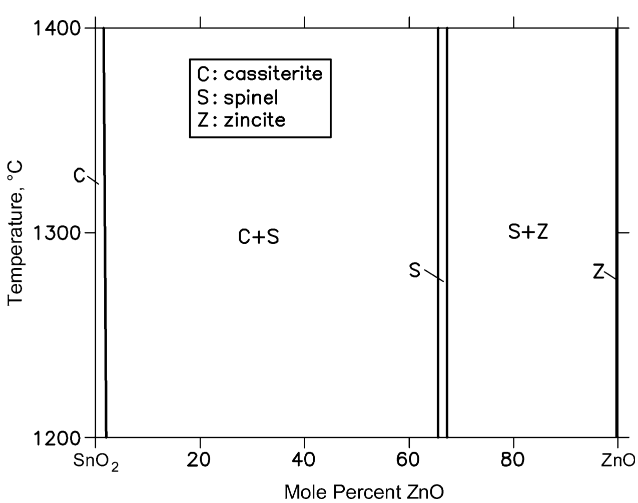

Fig. 1 SnO_2-ZnO pseudo-binary section in air [2004Han]

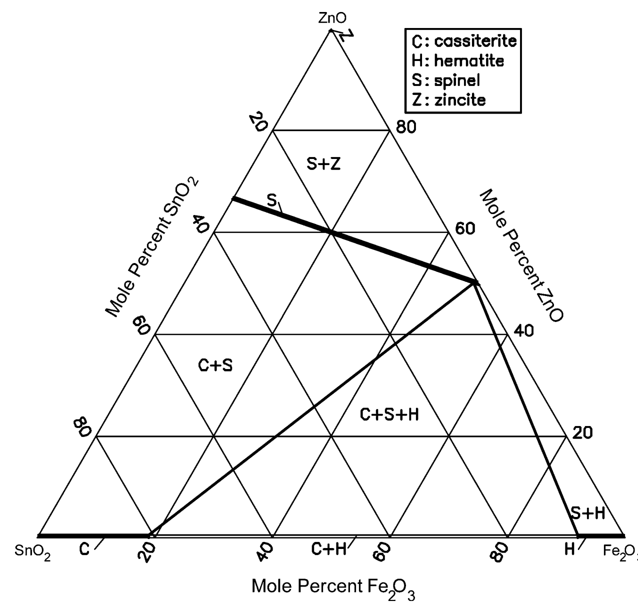

Fig. 2 Fe-O-Sn-Zn isothermal section at 1060 °C on the Fe_2O_3-SnO_2-ZnO plane [1981Tys]

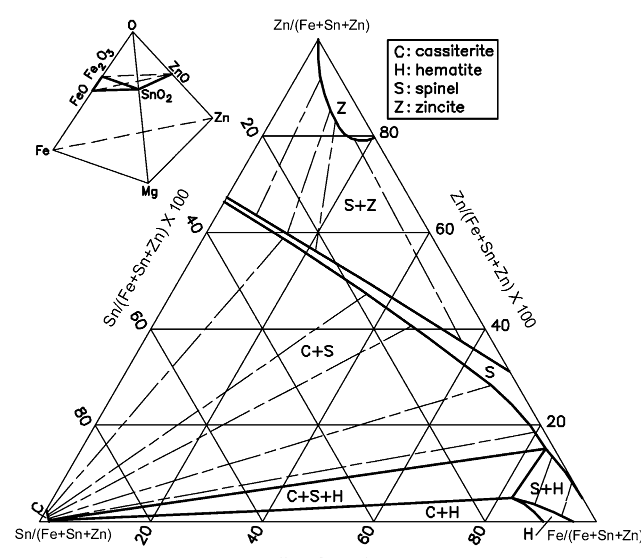

Fig. 3 Fe-O-Sn-Zn isothermal equilibria in air at 1400 °C projected on to the Fe-Sn-Zn plane [2004Han]

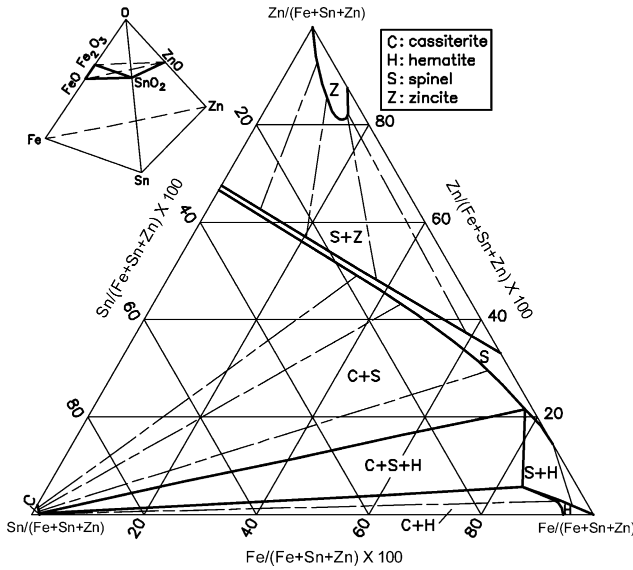

Fig. 4 Fe-O-Sn-Zn isothermal equilibria in air at 1300 °C projected on to the Fe-Sn-Zn plane [2004Han]

a positive deviation from Vegard's law. The solubility of 19 mol.% of Fe_2O_3 in cassiterite (SnO_2) measured by [1981Tys] is higher than that found by [2004Han].

With starting powders of Fe_2O_3, SnO_2, and ZnO (99.5+% purity), [2004Han] annealed pellets of powder mixtures at 1400 and 1300 °C for 20-117 h, followed by air quenching. The microstructures were studied with optical and scanning electron microscopy. The phase compositions were determined with electron probe microanalyzer and listed. The relative concentration of ferrous and ferric ions was not determined.

The isothermal equilibria in air were plotted as projections on the Fe-Sn-Zn plane. Figures 3 and 4 show these projections at 1400 and 1300 °C [2004Han]. More iron dissolves in spinel, as the composition approaches the Fe-corner. At 1400 °C (Fig. 2), there is complete solubility between $ZnFe_2O_4$ and Fe_3O_4. Cassiterite (SnO_2) dissolves less than 1 mol.% of Fe and about 1.5 mol.% of ZnO. Zincite (ZnO) dissolves up to 5 mol.% Sn.

References

1981Tys: R.M. Tyson and L.L.Y. Chang, The Systems ZnO-Fe_2O_3-SnO_2 and MgO-Fe_2O_3-SnO_2 at 1060°C, *Commun. Am. Ceram. Soc.*, 1981, **1**, p C4-C6

2004Han: R. Hansson, P.C. Hayes, and E. Jak, Experimental Study of Phase Equilibria in the Fe-Sn-Zn-O System in Air, *Can. Metall. Q.*, 2004, **43**(4), p 545-554