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# Al-Fe-O-Zn (Aluminum-Iron-Oxygen-Zinc)

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Recently, [2004Han] investigated the phase equilibria of this quaternary system in the $Al_2O_3$-FeO-$Fe_2O_3$-ZnO region and presented isothermal projections in air at 1550, 1400 1250 °C on the Al-Fe-Zn plane.

## Ternary Subsystems

Updates on the Al-Fe-O and Fe-O-Zn systems appear in this issue. The phase equilibria with emphasis on the metal-rich region of these ternary systems were reviewed earlier by [1989Rag1] and [1989Rag2] respectively. As part of their quaternary investigation, [2004Han] constructed a pseudo-binary section along the $Al_2O_3$-ZnO join. This is shown in Fig. 1, along with the results in the liquid region from [1932Bun]. The same experimental procedures as outlined below for the quaternary equilibria were employed by [2004Han]. Referring to Fig. 1, about 2 mol.% ZnO dissolves in corundum ($Al_2O_3$) between 1250 and 1695 °C. The solubility of $Al_2O_3$ in zincite (ZnO) is 4.7 mol.% at 1695 °C and decreases rapidly to $<0.5$ mol.% at 1550 °C and below. When in equilibrium with zincite, the composition of spinel is close to gahnite ($ZnAl_2O_4$). In spinel in equilibrium with corundum, the solubility of $Al_2O_3$ increases with increasing temperature, Fig. 1.

## Quaternary Phase Equilibria

With starting powders of $Al_2O_3$, $Fe_2O_3$ and ZnO (99.5+% purity), [2004Han] prepared pellets of powder mixtures, which were annealed for 114-306 h at 1250 °C, 16-66 h at 1400 °C or 4-21 h at 1550 °C and air cooled.

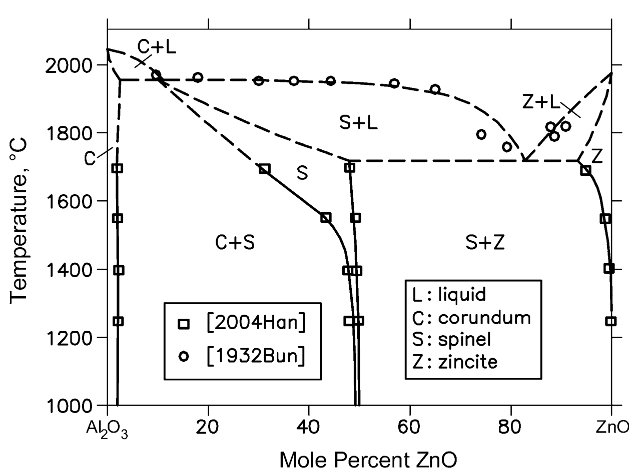


**Fig. 1** $Al_2O_3$-ZnO pseudo-binary section in air [2004Han]

The microstructures were examined with optical and scanning electron microscopy and the phase compositions were measured with electron probe microanalyzer and

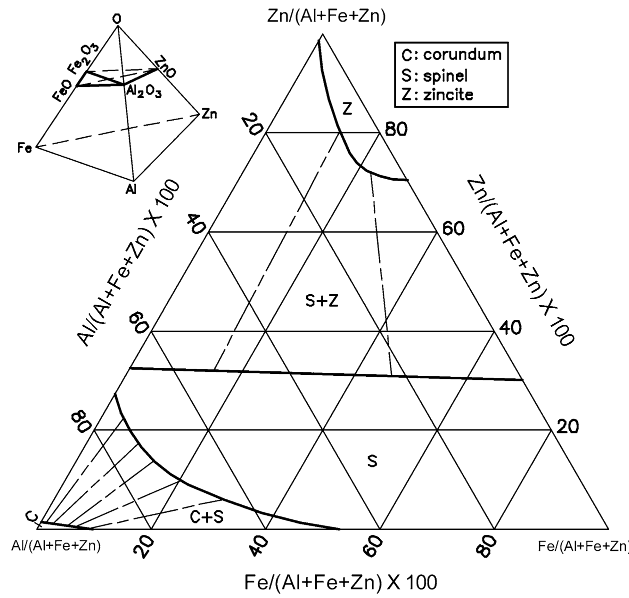


**Fig. 2** Al-Fe-O-Zn isothermal equilibria in air at 1550 °C projected on to the Al-Fe-Zn plane [2004Han]

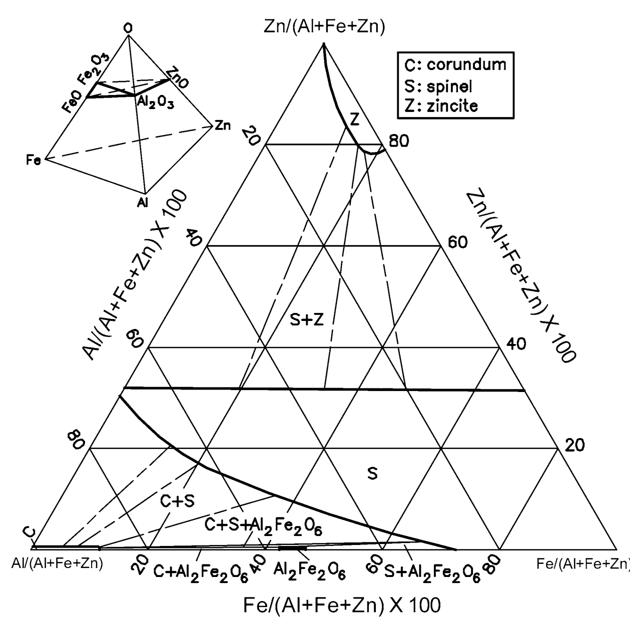


**Fig. 3** Al-Fe-O-Zn isothermal equilibria in air at 1400 °C projected on to the Al-Fe-Zn plane [2004Han]

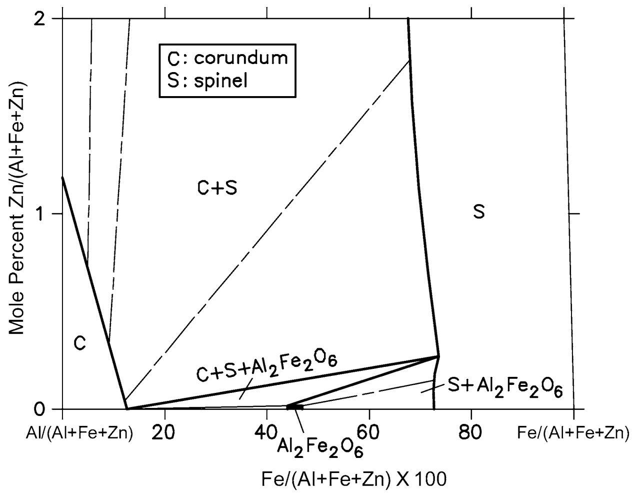


**Fig. 4** Al-Fe-O-Zn enlarged part of Fig. 3, depicting the equilibria at small concentrations of Zn [2004Han]

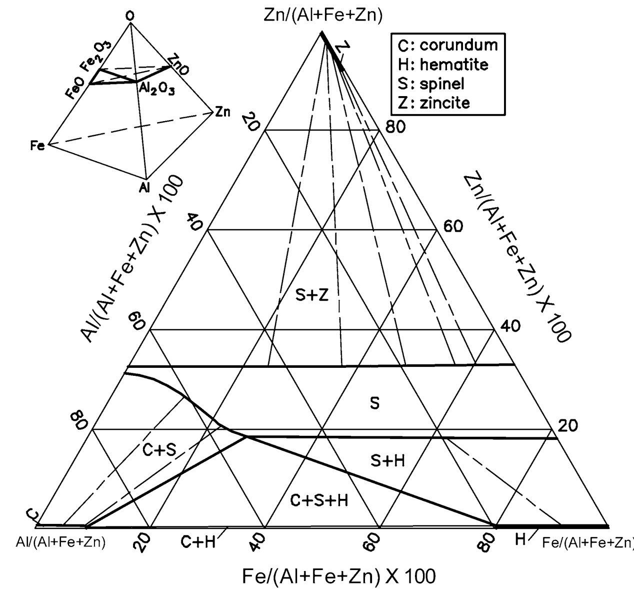


**Fig. 5** Al-Fe-O-Zn isothermal equilibria in air at 1250 °C projected on to the Al-Fe-Zn plane [2004Han]

listed. The data were presented as isothermal equilibria projected on the Al-Fe-Zn plane.

At 1550 °C (Fig. 2), corundum, spinel, and zincite are stable. Corundum dissolves a maximum of 9 mol.% Fe. The maximum Al content of zincite is about 6.5 mol.%. At 1400 °C (Fig. 3), the ternary phase $Al_2Fe_2O_6$, in equilibrium with corundum and spinel, contains 57 mol.% Al and $<1$ mol.% Zn. The Fe and Zn contents of the corundum phase, in three-phase equilibrium with $Al_2Fe_2O_6$ and spinel, are 13 and $<1$ mol.% respectively. Figure 4 shows the details of the phase relationships at small Zn concentrations. At 1250 °C (Fig. 5), for the three-phase equilibria of corundum, spinel and hematite, the composition of corundum is 9 mol.% Al and $<1$ mol.% Zn. The corresponding spinel composition is 54, 27 and 19 mol.% Al, Fe and Zn respectively. Hematite contains 19 and $<1$ mol.% of Al and Zn respectively. The Zn content of the spinel phase in equilibrium with zincite is nearly constant at 33 mol.%.

## References


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