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# Cd-Fe-Se (Cadmium-Iron-Selenium)

*V. Raghavan*

Dilute magnetic (or semi-magnetic) semiconductors are a class of semiconductors, in which a transition metal atom such as Fe is incorporated in the host lattice of an otherwise nonmagnetic semiconductor. The solubility of the transition metals is appreciably larger in II-VI semiconductors than in III-V and elemental semiconductors [1993Kle]. A partial diagram for the CdSe-$FeSe_{1.24}$ pseudobinary section was determined by [1993Wie].

## Binary Systems

The mutual solubility between Cd and Fe is negligible, and there are no intermediate phases in the Cd-Fe system. In the Cd-Se binary system [Massaslki2], there is one stoichiometric compound CdSe, which forms congruently from the melt at 1264 °C. It has the ZnS (wurtzite)-type hexagonal structure. The Fe-Se phase diagram [1991Oka] depicts a number of modifications of the monoselenide around the mid-composition: $\beta Fe_{1.04}Se$, $\gamma Fe_{1-x}Se$, $\gamma' Fe_{1-x}Se$, $\delta Fe_{1-x}Se$, and $\delta' Fe_{1-x}Se$. $\beta Fe_{1.04}Se$ has the tetragonal PbO type structure. $\delta Fe_{1-x}Se$ (49.5-58 at.% Se) is a NiAs-type hexagonal phase. The other phases are NiAs-related phases. $FeSe_2$ has the $FeS_2$ (marcasite) type orthorhombic structure. For more structural details, see [1991Oka].

## The CdSe-$FeSe_{1.24}$ Pseudobinary Section

Using starting materials of purity of 99.9999% Cd, 99.999% Fe, and 99.999% Se, [1993Wie] first prepared the binary compounds CdSe and $FeSe_{1.24}$. The composition

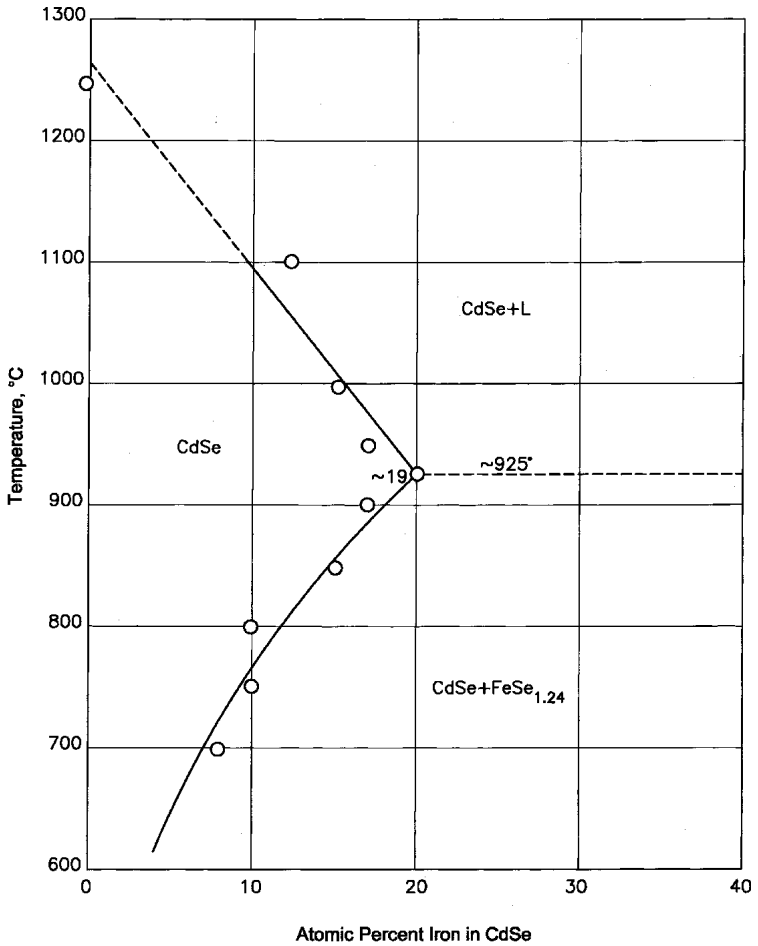


**Fig. 1** Cd-Fe-Se partial pseudobinary section along the CdSe-$FeSe_{1.24}$ join [1993Wie]

$FeSe_{1.24}$ (55.4 at.% Se) was chosen so that it lies in the region of the δ (NiAs type) phase. The binary compounds were mixed in the desired ratios and were annealed between 650 and 1100 °C for 3-4 d and quenched in water. The phase equilibria were studied by the x-ray parametric method. Here, the constancy of the lattice parameters beyond a certain concentration of the second component is used to identify the solubility limit. The partial section determined by [1993Wie] is shown in Fig. 1. The solubility of Fe in CdSe is less than 5 at.% at 600 °C and increases to about 19 at.% at 925 °C, where a eutectic reaction is indicated from metallographic observations. Additional experiments by [1993Wie] with compositions near the $FeSe_{1.24}$ end indicate a simple eutectic type of diagram, with the solubility of CdSe in $FeSe_{1.24}$ at <4 mol % at 850 °C and below.

## References

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