JPEDAV (2007) 28:289–290
DOI: 10.1007/s11669-007-9073-2
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Cr-Fe-Mn-N-Ni (Chromium-Iron-Manganese-Nitrogen-Nickel)

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[1992Raw] investigated the influence of nitrogen pressure on its solubility in the Cr-Fe-Mn-Ni alloys. Partial phase relationships in this quinary system were determined by [2000Sop], who presented computed isothermal sections at 1,000 and 800 °C and compared them with their experimental data.

Lower Order Systems

The 10 binary and the ten ternary subsystems of this quinary system are covered in the two quaternary subsystems Cr-Fe-Mn-N and Cr-Fe-N-Ni, reviewed by [1996Rag], with the exclusion of those containing both Mn and Ni: Mn-Ni binary and Cr-Mn-Ni, Fe-Mn-Ni, and Mn-N-Ni ternaries. [2000Sop] used the quaternary assessments of Cr-Fe-Mn-N and Cr-Fe-N-Ni from [1993Qiu] and [1991Fri] respectively.

Quinary Phase Equilibria

[1992Raw] arc-melted two quaternary alloys of composition in weight percent: 15Cr-5Mn-10Ni and 15Cr-10Mn-5Ni. The alloys were kept at 1650 °C for 60 min under a nitrogen pressure of 0.1, 10, or 200 MPa. Phase identification was carried out by examining the surfaces with x-ray diffraction and the microstructure was characterized by the scanning electron microscope. The solubility of nitrogen was found to be proportional to the square root of the gas pressure, obeying Sievert's law. Nickel decreases the nitrogen solubility, while Cr and Mn increase it. When the saturation limit is reached, metal nitrides Fe_4N, Fe_2N, Cr_2N, CrN, and Mn_4N form.

[2000Sop] induction-melted six Fe-based quaternary alloys containing in weight percent 20.6-21.7 Cr, 17.6 Mn, and 2.2-6.5 Ni. These alloys were nitrogenated between 1300 and 1400 °C at $p_{N_2} = 0.4$ bar. The nitrogen analysis by the hot extraction technique showed a nitrogen content of 0.506-0.797 wt.%. The nitrogenated samples were annealed in evacuated sealed tubes at 1000 °C for 260 h or at 800 °C for 1850 h and quenched in water. The phase equilibria were studied by scanning electron microscopy, wavelength-dispersive and energy-dispersive x-ray analysis, and selected area diffraction with transmission electron microscopy. The phases identified are: face-centered cubic (fcc) solid solution, hcp nitride (ε) , and CrFe (σ).

[2000Sop] computed the phase equilibria of the quinary system, using the interaction parameters obtained by [1993Qiu] for the Cr-Fe-Mn-N system and by [1991Fri] for the Cr-Fe-N-Ni system. Due to inadequacy of the new experimental data, no attempt was made to improve the known interaction parameters or to find new higher-order parameters. Four isothermal sections were computed at 1300, 1227, 1000, and 800 °C, $p_{N_2} = 1$ bar and constant contents of 21 wt.% Cr-17.5 wt.% Mn. The computed isothermal sections at 1000 and 800 °C are compared with

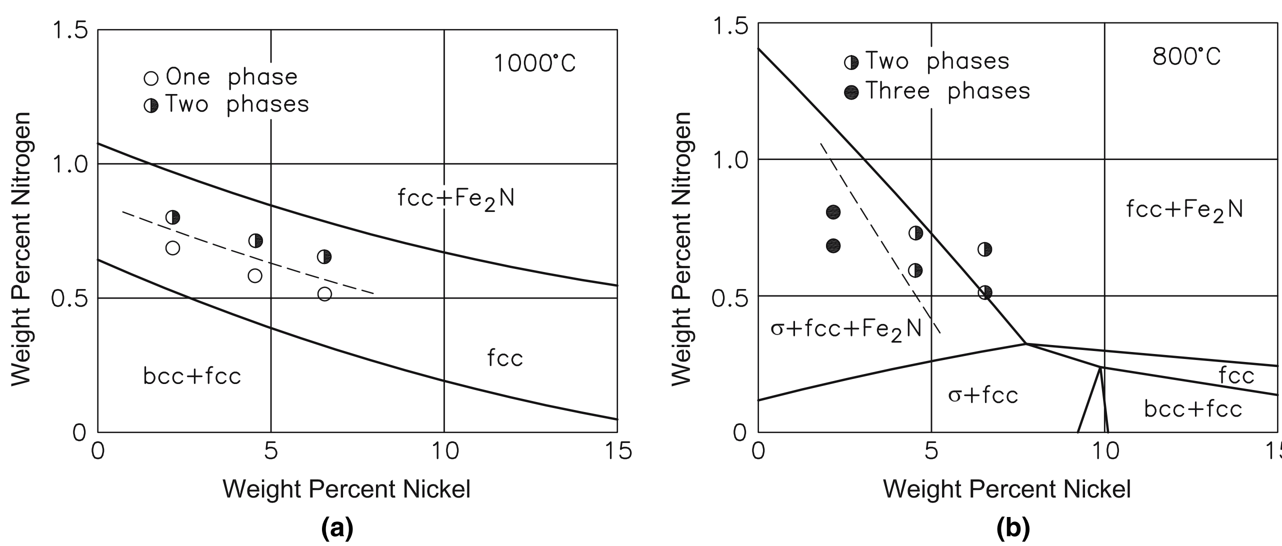

Fig. 1 Cr-Fe-Mn-N-Ni computed isothermal sections at 1 bar, 21 wt. % Cr, and 17.5 wt.% Mn [2000Sop]

the experimental data in Fig. 1a, b. The agreement between computed and experimental boundaries needs improvement. Two vertical sections were also calculated between 400 and 1600 °C, at $p_{N_2} = 1$ bar and at 21 wt.% Cr-17.6 wt.% Mn-4.5 wt.% Ni and at 21 wt.% Cr-17.6 wt.% Mn-0.6 wt.% N respectively.

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