JPEDAV (2007) 28:282–283
DOI: 10.1007/s11669-007-9075-0
1547-7037 ©ASM International

C-Fe-N-V (Carbon-Iron-Nitrogen-Vanadium)

V. Raghavan

Recently, [2005Pop] made a thermodynamic analysis of this quaternary system and computed equilibrium fractions of phases at 1100, 1000 and 900 °C for a steel with 0.1 wt.% C and 0.01 wt.% N. Also, the computed composition and amount of the carbonitride phase V(C,N) was presented as a function of C and N, as perspective views at 1000 °C for steels containing either 0.1 or 0.5 wt.% V.

Quaternary Phase Equilibria

Among the four ternary subsystems, [2005Pop] used the description of [1991Hua] for the C-Fe-V system and its binary subsystems. For the Fe-N-V system, the Fe-V description of [1991Hua], the Fe-N description of [1991Fri] and a modified V-N description were used by [2005Pop]. For the Fe-C-N system, the descriptions of Fe-C binary from [1985Gus] and of Fe-N from [1991Fri] were used. For the V-C-N system, the subsystems of C-V and N-V were combined, omitting ternary interactions. In the computation, no quaternary interactions were considered.

[2005Pop] presented computed isothermal sections for the C-Fe-V and Fe-N-V ternary systems at 1000 and 1200 °C. For the quaternary system, liquid, face-centered cubic solid solution (fcc) γ, body-centered cubic solution (bcc) α, cementite ($D0_{11}$-type orthorhombic), cubic carbonitride ($B1$, NaCl-type), hexagonal carbonitride, σ ($D8_b$-type tetragonal), and free nitrogen were considered in the thermodynamic description. In Fig. 1, the equilibrium phase fractions of γ, α, V(C,N), and V_2(C,N) are plotted as a function of V content at 1100, 1000, and 900 °C for a steel containing 0.1 wt.% C and 0.01 wt.% N. The σ phase does not occur at the V concentrations shown in Fig. 1. Also, the hexagonal carbonitride V_2(C,N) forms only at high V concentrations (not present in low-alloy steels).

Figure 2 shows as perspective views, the computed composition and amount of the carbonitride in equilibrium with austenite as a function of C and N in a steel with 0.1 wt.% V at 1000 °C. At this temperature, no carbonitride forms in the absence of nitrogen. Also, the amount of C in V(C,N) is small. A similar plot was given by [2005Pop] for a steel with 0.5 wt.% V at 1000 °C (not shown here). With 0.5 wt.% V, carbon was found to exert a greater influence on

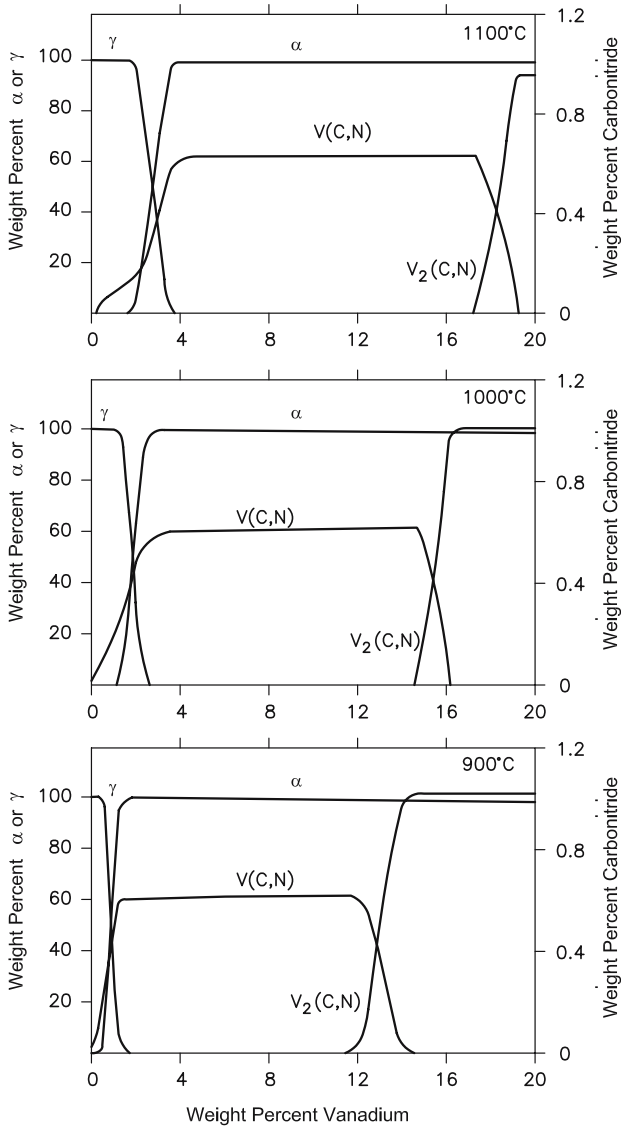

Fig. 1 C-Fe-N-V computed phase fractions at 1100, 1000 and 900 °C for steels with 0.1 wt.% C and 0.01 wt.% N [2005Pop]

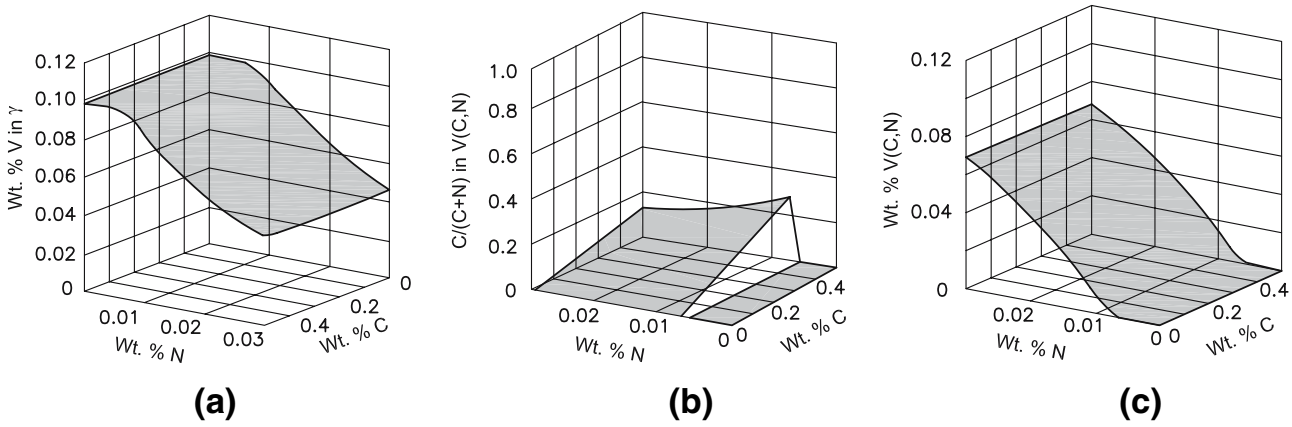

Fig. 2 C-Fe-N-V perspective views of computed (a) V content in γ (austenite), (b) composition of V(C,N), and (c) amount of V(C,N), in steel with 0.1 wt.% V at 1000 °C [2005Pop]

the carbon content and the amount of the carbonitride phase in equilibrium with austenite.

References

1985Gus: P. Gustafson, A Thermodynamic Evaluation of Fe-C System, *Scand. J. Metall.*, 1985, **14**(5), p 259-267

1991Fri: K. Frisk, A Thermodynamic Evaluation of the Cr-N, Fe-N, Mo-N and Cr-Mo-N Systems, *CALPHAD*, 1991, **15**(1), p 79-106

1991Hua: W. Huang, A Thermodynamic Evaluation of the Fe-V-C System, *Z. Metallkd.*, 1991, **82**(5), p 391-401

2005Pop: V.V. Popov and I.I. Gorbachev, Analysis of Solubility of Carbides, Nitrides, and Carbonitrides in Steels Using Methods of Computer Thermodynamics: II. Solubility of Carbides, Nitrides, and Carbonitrides in the Fe-V-C, Fe-V-N and Fe-V-C-N Systems, *Fiz. Met. Metalloved.*, 2005, **99**(3), p 69-82, in Russian; TR: *Phys. Met. Metallogr.*, 2005, **99**(3), p 286-299