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Effect of Vanadium Addition on the Solubility of W in a Co Melt

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1. Introduction

Grain growth in submicron sized WC-Co alloy was inhibited by the addition of second carbide such as VC, Cr₃C₂ etc. A few mechanisms were reported about these phenomena. The first one is that the segregation of VC retards the growth of WC during sintering process. But this segregation is not occurred during sintering process but during cooling process by the difference of solubility in various temperature. Second one is that the reduction of edge energy of WC inhibited the grain growth in 2-D nucleation model. However, it is difficult to estimate the decreased energy of WC quantitatively.

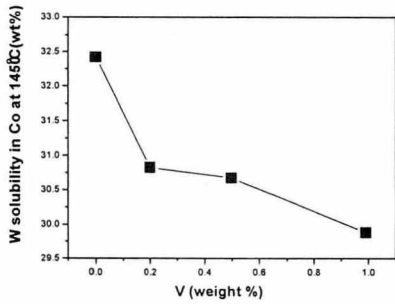
In this presentation, we suggest a new mechanism by negative interaction coefficient between V and W in Co melts. In the liquid Co melts at 1450°C, the interaction coefficient between V and W was estimated and compared with calculated ones from phase diagrams. From this experiments, it was considered that the grain growth inhibition in WC-Co system was caused by the negative interaction between V and W.

2. Experimental

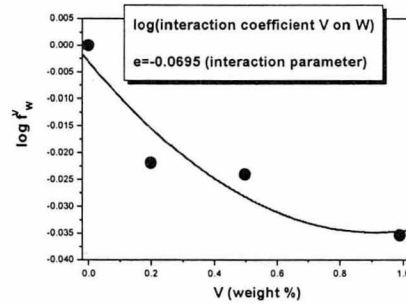
Co-V-W alloy was manufactured by induction melting furnace at 1450°C for 1hr under vacuum. Powder mixture of Co and V was prepared by mixing and drying. And then rod type W was buried into Co and V mixture. After sealing of this specimen in quartz tube under vacuum, it was melted in induction melting furnace. That tube was quenched into water to observe the solubility at 1450°C. For the elemental analysis, SEM/EDS and ICP(inductively coupled plasma) was used.

3. Result and Discussion

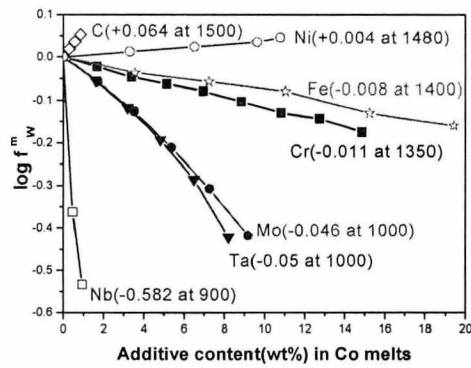
Figure 1 (a) shows the solubility of W in Co at 1450°C with contents of V. It is observed that the increase of V in Co makes the decrease of W in Co melts. In Fig.1(b), interaction coefficient V on W(f_w^v) was estimated by thermodynamic calculation. That coefficient was decreased with increase of V. The initial slope of the logarithm of interaction coefficient, that is interaction parameter, was about -0.07 by second polynomial fitting. Figure 1(c) shows the calculated interaction parameters from phase diagram at various metal and temperature. From this, the value of negative parameter($e=-0.07$) between V and W is very higher than the one of other system(more negative). It means that the presence of V in Co melts retards the dissolving of W into Co effectively. It made the grain growth inhibition in WC-Co alloy systems.



(a)



(b)



(c)

Fig.1(a) solubility of W in Co melt at 1450°C (b) the logarithm of interaction coefficient with V content in Co melts and (c) calculated interaction parameters of various metal and temperatures.

4. Conclusion

Because of the negative interaction between V and W, the presence of V in Co melts retards the dissolving of W into Co effectively. It made the grain growth inhibition in WC-Co alloy systems.