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The Modelling on Relationship between Temperature and Gibbs free energy and Composition in Solidification

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Abstract

The temperature difference ΔT decreases from 0 to 190K if composition difference ΔCom increases from 0 to 0.18 respectively. The temperature decreases with increasing constitutional supercooling. The temperature decreases with increasing ΔT. The temperature changes from 2,250K to 1,300K in ΔT=30K, meanwhile it decreases from 2,250K to 2180K with the constitutional supercooling increasing from 30K to100K. With increasing constitutional supercooling ΔT from 30K, 100K, 200K, 300K to 400K the free energy will be lower from -3,300J, -3,600J, -3,800J, -4,200J to -4,400J. It means that with increasing constitutional supercooling the easy solidification will be formed.

Keywords: Modelling; Relationship; Temperature; Gibbs free energy; Composition; Solidification; Constitutional supercooling

Introduction

Introduction

The temperature and composition with constitutional supercooling has been important in solidification of metal. So that the modelling on relationship between them are established to study the parameters on them in detail is significant in materials research. For the convenience the data adopted from phase diagram and experience to ensure the correction of them. The result has been found to be consistent with the practice well so the further search is been studied to look forwards to anticipating good effectiveness [1-9]. As we know the constitutional cooling is the important cooling which is different to usual cooling Therefore the related search will be proceeded to find its role on solidification of metal. When it attains near the solid and liquid line the constitutional supercooling will be formed to drive the nuclear crystal to form. So it is important at the solidification course in special the original solidification to new crystal. Constitutional supercooling is formed by solute redistribution to cause solute concentration change in front of solid and liquid interface which causes to change theory solidification temperature for forming the super cooling in interface liquid. From line equation the cooling and constitutional super cooling has been formed through phase diagram method. The constitutional cooling is checked through chart to find the difference with its change. As we knew the constitutional supercooling benefits to the cooling course since its high temperature the way to choose reasonable value is necessary.

Discussions

It is searched that relationship between composition difference from 0 to 0.2 and temperature difference firstly. Then the chart between the temperature and composition from 0 to 1 with constitutional supercooling. At last the Gibbs free energy with Al composition under different constitutional supercooling like 30K, 100K, 200K, 300K and 400K is been studied. The details discussion is as below (Figure 1).

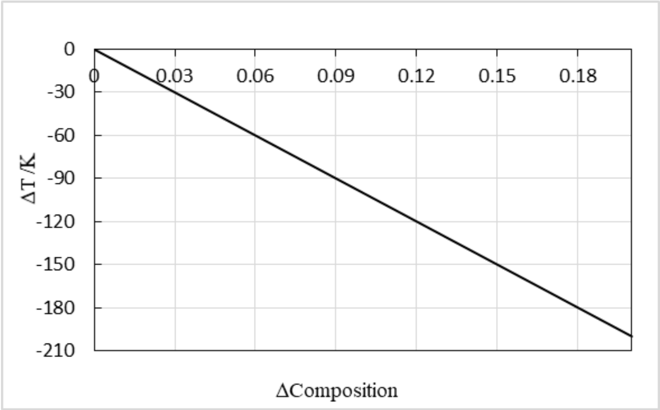
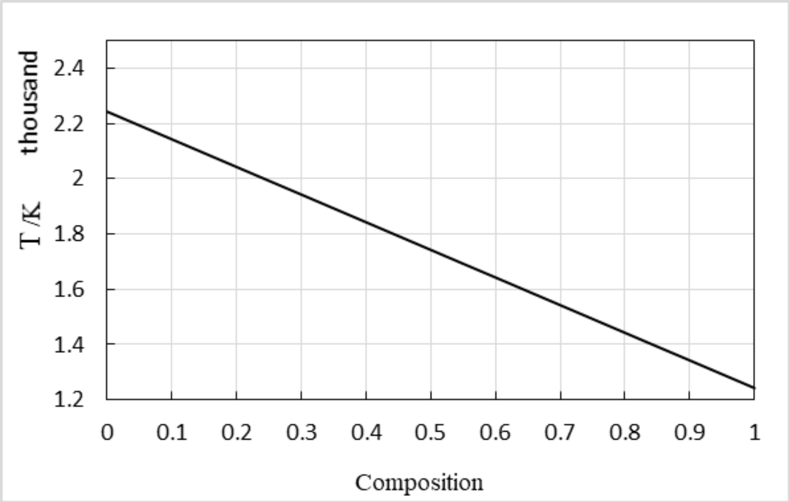
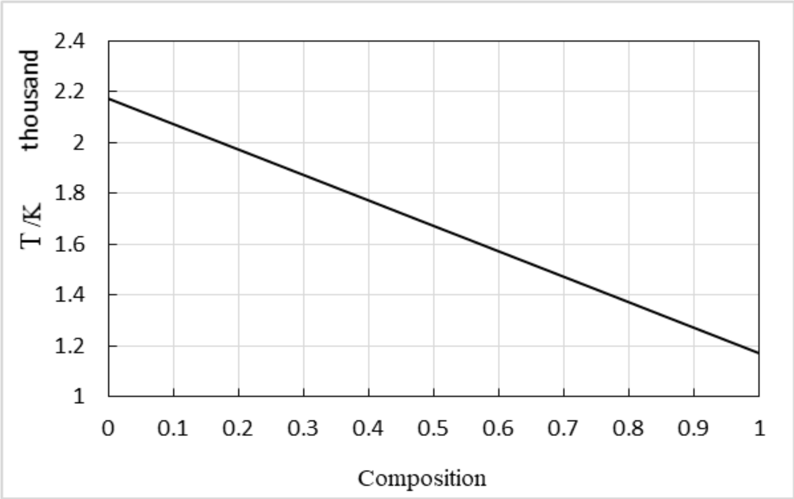


Figure 1: *The relationship between temperature difference and composition difference in TiAl alloy.*

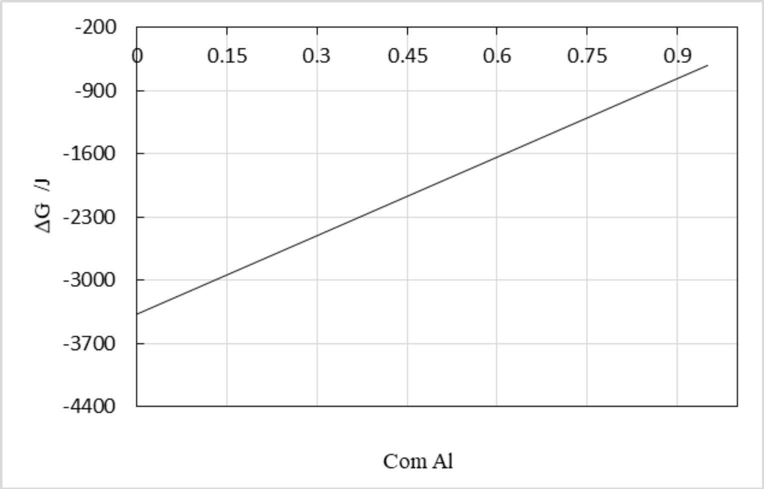


(a) ΔT=30K

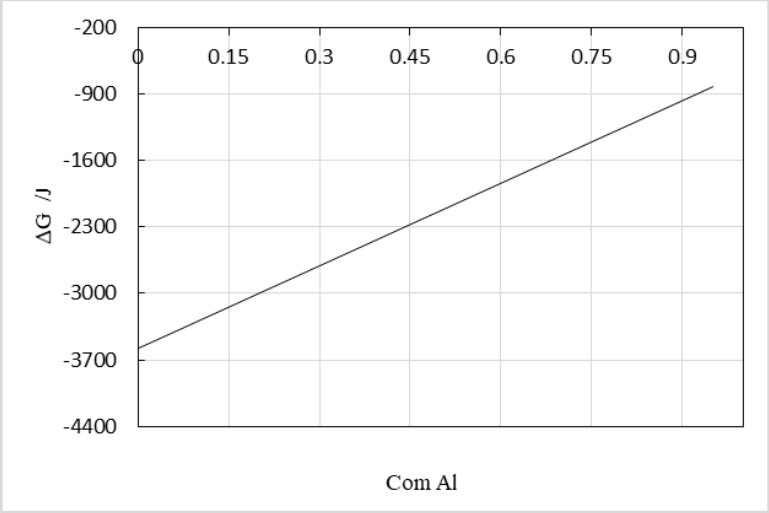


(b) ΔT=100K

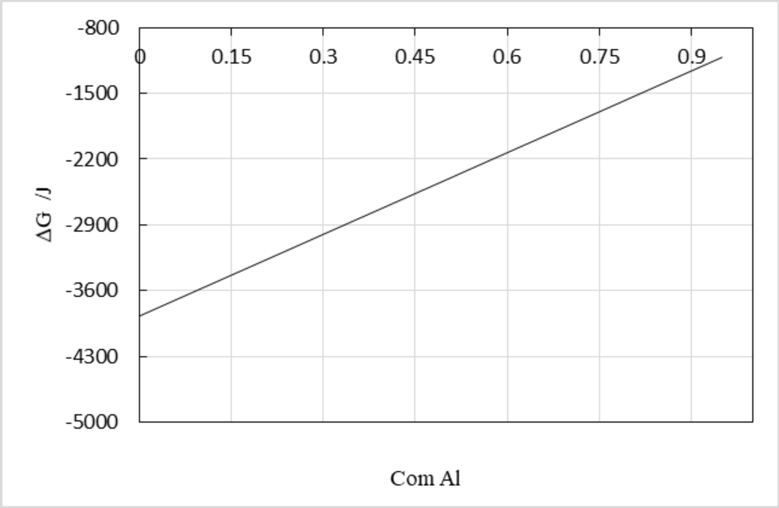
Figure 2: *The relationship between temperature and composition with constitutional supercooling ΔT in TiAl alloy.*



(c) ΔT=30K



(d) ΔT=100K



(e) ΔT=200K

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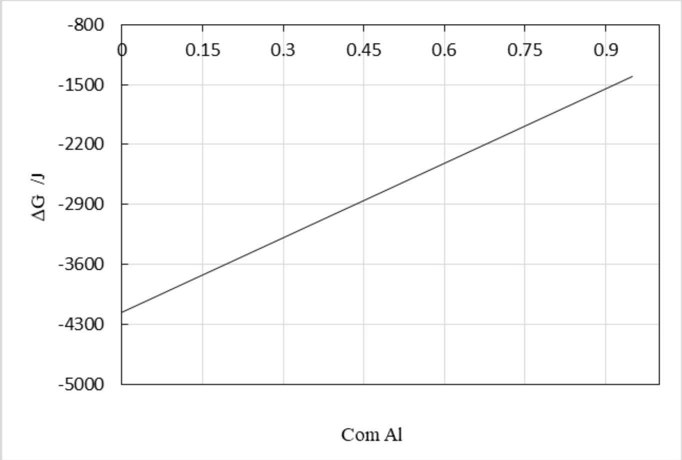
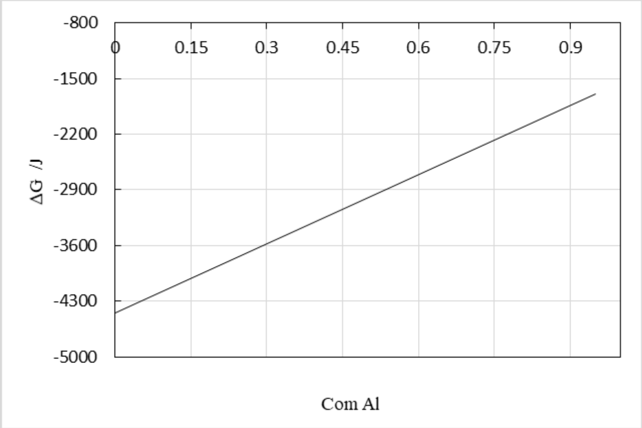


(f) ΔT=300K



(g) ΔT=400K

Figure 3: *The chart on Gibbs free energy and composition with constitutional super cooling ΔT in TiAl.*

As seen in Figure 1 the temperature difference ΔT decreases from 0 to 190K if composition difference ΔCom increases from 0 to 0.18 respectively. In general the composition scope arranges from 0.01 to 0.12 so the ΔT arranges from 10K to 120K in TiAl alloys according to the modelling. As seen in Figure 2 the temperature decreases with increasing constitutional supercooling. The temperature decreases with increasing ΔT. The temperature changes from 2,250K to 1,300K in ΔT=30K, meanwhile it decreases from 2,250K to 2,180K with the constitutional supercooling increasing from 30K to100K (Figure 2,3).

As seen in Figure 3 the Gibbs free energy difference will increase when composition Al increases in Ti-Al. Furthermore with increasing constitutional supercooling ΔT from 30K, 100K, 200K, and 300K to 400K the free energy will be lower from -3,300J, -3,600J, -3,800J, -4,200J to -4,400J. It means that with increasing constitutional supercooling the easy solidification will be formed. Therefore the higher ΔT will promote the speed of solidification in Ti-Al. In detail with changing from-1,600J to -700J with changing Al from 0 to 1 in constitutional supercooling ΔT =400K. It is better situation since low energy.

Conclusions

The temperature difference ΔT decreases from 0 to 190K if composition difference ΔCom increases from 0 to 0.18 respectively. The temperature decreases with increasing constitutional supercooling. The temperature decreases with increasing ΔT. The temperature changes from 2,250K to 1,300K in ΔT=30K, meanwhile it decreases from 2,250K to 2180K with the constitutional supercooling increasing from 30K to100K. With increasing constitutional supercooling ΔT from 30K, 100K, 200K, 300K to 400K the free energy will be lower from -3,300J, -3,600J, -3,800J, -4,200J to -4,400J. It means that with increasing constitutional supercooling the easy solidification will be formed.

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