



The Modelling of Parameters between Secondary Arm Space and Solidification Speed with Composition and Temperature in TiAl

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Abstract

The parameters simulation of secondary arm space & composition has been established for the sake of searching their intrinsic relationship. The secondary arm space difference is 1.1mm when the composition difference is 0.05. The value of space difference is big somewhat that explains the composition difference is an important factor to affect the space difference. The solidification speed changes from 1600mm/hr, 1570mm/hr, and 800mm/hr to 700mm/hr when the temperature increases from one small value like 5K, 10K, 30K, and 40K to 400K. The solidification speed is non proportional to temperature. The speed will increase with decreasing temperature with difference ΔT . From curve it is seen that the temperature value is too low so maybe the constant is uncertain.

Keywords: Modeling; TiAl; Dendrite; The secondary arm space; Analysis; Temperature; Solidification speed; composition; Difference; Constitutional supercooling

Introduction

The change of temperature in the solid and liquid in solidification transformation can deduce their related formula. The curve expresses its trend better. From this relation their secondary dendrite arm space composition will change when the transformation happens. It is known that the temperature in solidification can solve their relationship. In this study in terms of these equations the deduction and analysis is done and the error analysis to them is done. Here the solid and liquid equation is explored within line and find the simple formula which make us to calculate the cooling rate rapidly [1-3]. Therefore in this study the model of temperature and composition has been established to observe the trend and intrinsic relationship between them. Then the error is checked with variance to both of constant. TiAl as a promise materials has been searched and developed for many years. However the cooling rate with compositions is not much yet, so in this study the equation is established through temperature and composition according to the phase diagram. It is modelled with cooling rate and composition difference too in

directional solidification test. The detail value is combined through phase equilibrium line and it is compared with thermal dynamics. The research scope is from 0 to pure Al here. On the other side the relationship with cooling rate and energy difference & temperature has been investigated according to varied speed respectively for the application. According to the solidification crystalline and phase diagram the application will be known. In addition relationship between cooling rate and energy difference & temperature are drawn for further research in this study. To calculate the cooling rate is our destination in the end in terms of the composition in TiAl alloys. Therefore the establishment equation between temperature and cooling rate in terms of the equilibrium diagram [3-8]. In short the detail research for TiAl dendrite parameters has been necessary and important currently. The constitutional supercooling as an important factor to affect the dendrite solidification in TiAl alloys. Therefore only if both of them has been searched the detail aspect will be found by deep foundation. Their deep study will be destination to us in this paper.

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Discussion and Simulation

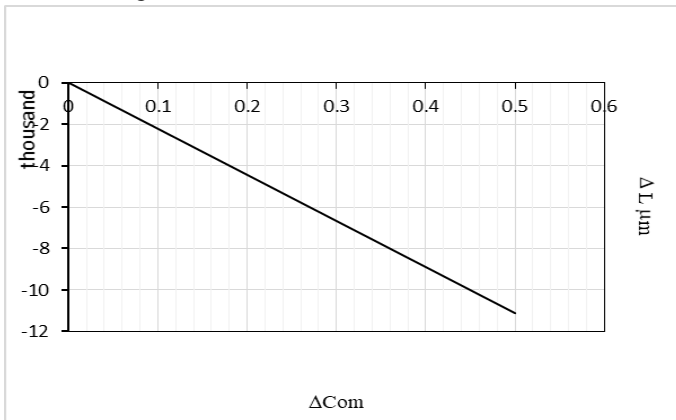
The modelling has been established according to equations as below. In terms of equations deduced equations it has

$$\Delta T = -1000\Delta C_{om} \quad \text{--- (1)}$$

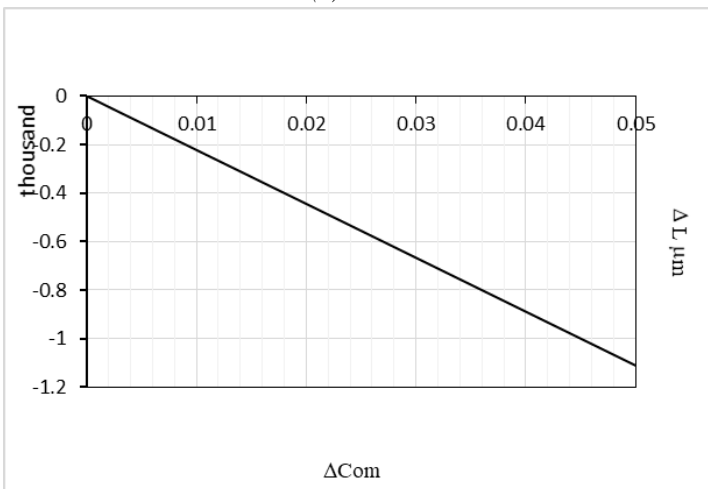
$$\Delta T = 45\Delta L \quad \text{--- (2)}$$

$$V = 2.2/T \quad \text{--- (3)}$$

Here T and ΔT is temperature and its difference K; ΔC_{om} is composition difference; ΔL is the secondary arm space mm; V is solidification speed mm/s. As seen in Figure 1(a, b) when the composition difference attains 0.5 the secondary arm space difference will arrive 11mm. Figure (b) is a part of Figure 1(a). From Figure 1 (b) it is known that the secondary arm space difference is 1.1mm when the composition difference is 0.05. The value of space difference is big somewhat that explains the composition difference is an important factor to affect the space difference (Figure 1,2).



(a) $\Delta L = 0 \sim 0.5$

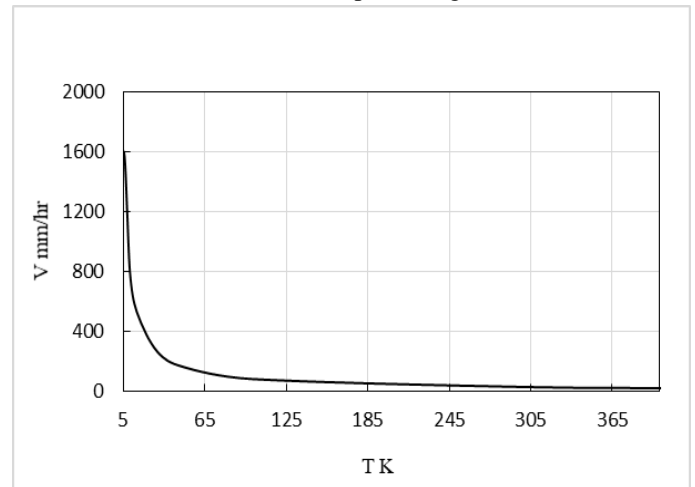


(b) $\Delta L = 0 \sim 0.05$

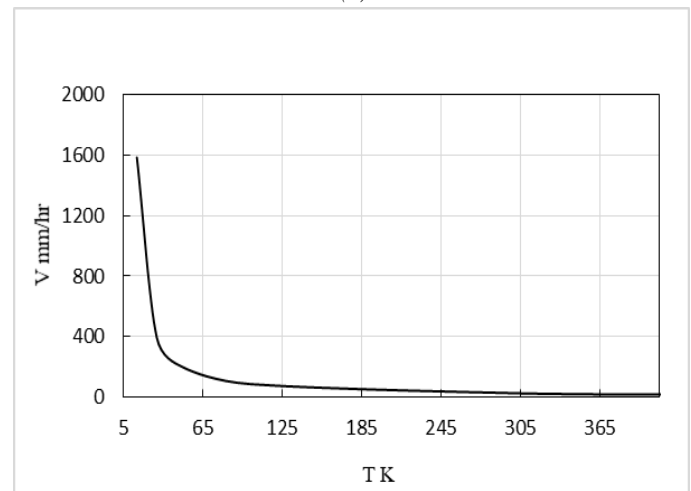
Figure 1: The graph of secondary arm space in dendrite and composition of Al in TiAl.

From Figure 2(a~d) the solidification speed decreases when the temperature increases. The former changes from 1600mm/hr, 1570mm/hr, 800mm/hr to 700mm/hr when the later increases

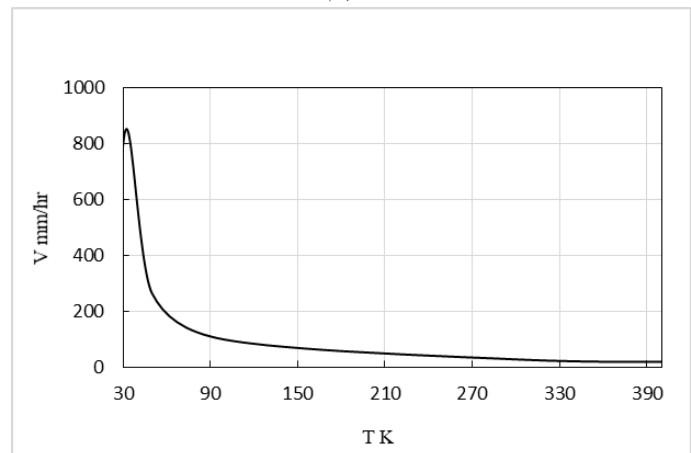
from one small value like 5K, 10K, 30K, 40K to 400K. The solidification speed is non proportional to temperature. It means that higher temperature is the little solidification speed will be. Here the temperature difference like $\Delta T = 10K, 20K \& 30K$ is used in order to build constitutional supercooling.



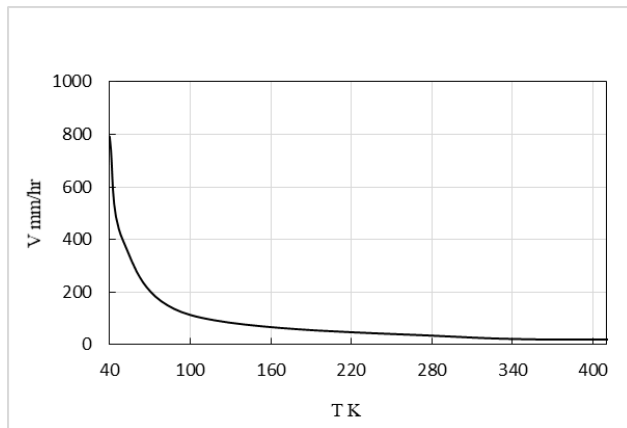
(a) $\Delta T = 0$



(b) $\Delta T = 10K$



(c) $\Delta T = 20K$



(d) $\Delta T=30K$

Figure 2: The graph of solidification speed and temperature with constitution supercooling in TiAl.

The speed will increase with decreasing temperature with difference ΔT . From curve it is seen that the temperature value is too low so maybe the constant is uncertain. It needs to be search further to build fitter one to upgrade it.

Conclusions

The secondary arm space difference is 1.1mm when the composition difference is 0.05. The solidification speed decreases when the temperature increases. The former changes from 1600mm/hr, 1570mm/hr, 800mm/hr to 700mm/hr when the later increases from one small value like 5K, 10K, 30K, 40K to 400K. The speed will increase with decreasing temperature with difference ΔT . From curve it is seen that the temperature value is too low so maybe the constant is uncertain. It needs to be search further to build fitter one to upgrade it.

References

1. Cai X. Fundamentals of Materials Science and Engineering, Shanghai Jiao Tong University. 2017; 174-175.
2. Hao S. Materials thermal dynamics, Chemical industry Press. 2004; 101.
3. Xu R, Kim Y. A study on cooling rate modelling of dendrite between the temperature and composition in TiAl Intermetallic Compounds. SunText Review Material Sci. 2022; 3: 123.
4. Xu R. A study on directional solidification and deformation behaviors by calculation in titanium aluminides. Gyeongsang National University. Metallurgical Materials Engineering Department PhD thesis dissertation. 2009; 12: 7.
5. Xu R, Lim S, Reddy NS, Nam T, Ahn HJ, Kim K, et al. The modelling of cooling rate between solidificational speed and

dendrite secondary arm space in TiAl intermetallic compounds II. SunText Review Material Sci. 2022; 3: 133.

6. Xu R, Nam T, Hyo Jun A, Reddy NS, Kim K, Kim Y, et al. The modelling on relationship between temperature and gibbs free energy and composition in solidification. SunText Review Material Sci. 2022; 3: 134.
7. Wang YM, Li S. Study on homogeneous structure DD6 in directional solidification of Single crystalline high temperature. Acta Metallurgica Sinica. 2015; 51: 1039.
8. Xu R. Effects of the composition on structures and mechanical properties of TiAl base intermetallic compounds. Gyeongsang National University. Metallurgical Materials Engineering Dept. Master thesis dissertation. 1999; 5.