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Model for Superplastic Deformaton of Ti_3Al Alloy

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Abstract: The method is recently developed to obtain the optimum superplastic property of Ti_3Al alloys. Mode is established, and after the calculation to analyze the present model the parameters is found fit to the curve expressing the high plastic well here. $m>K>n$ is the found turn in these three parameters which causes the superplasticity effectively, this effect may be studied further to demonstrate it to be effective definitely.

Keywords: superplastics; Ti_3Al; modeling

1 Introduction

The superplasticity on Ti_3Al has been prevalent recently in many researches. In some papers the conclusions are done as the strain sensitive exponent is one main parameter to cause the ductility and superplasticity. The studies research experimental data to explain the effective size to superplasticity. The superplasticity is high plastic behavior in alloys. for instance, many metal has this property which is concluded as three conditions. Firstly the high temperature; second the high strain rate; thirdly the small grain boundaries[1-2]. Only satisfied these three conditions can a metal wield this superplastic behavior. So this paper will analyzs and compute this behavior by using the different parameters such as n、m[3] and K to find the properties behaviors as well.

So we carry experimental data of Ti_3Al alloy to simulate the stress and strain curve to find their ductility and superplasticity[3]. To find the function these three parameters respectively we proceed chart to file up according to three conditions. We find the K and n are also two factors to affect the ductility. The results are fitting to well with the results m in literatures.

In some papers, it had been said that the superplasticity was obtained in terms of single crystalline. In some directions the superplastic behavior was observed. So that the directional superpalsticity will be discussed in the future.

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2 Modeling

Because

$$\sigma = K\varepsilon^{n} \tag{1}$$

and

$$\sigma = K_1\dot{\varepsilon}^{m} \tag{2}$$

$$\ln\sigma = \ln K + n\ln\varepsilon \tag{3}$$

$$\ln\sigma = \ln K_1 + m\ln\dot{\varepsilon} \tag{4}$$

And suppose first point coordination (ε_1, σ_1), we can get

$$\ln\sigma_1 = \ln K + n\ln\varepsilon_1 \tag{5}$$

$$\ln\sigma_1 = \ln K_1 + m\ln\dot{\varepsilon}_2 \tag{6}$$

Where: K is the strength coefficient; n is the strain hardening exponent; σ is the true flow stress, MPa; ε is the strain.

Also suppose second point coordination (ε_2, σ_2), we can get

$$\ln\sigma_2 = \ln K_1 + n\ln\varepsilon_2 \tag{7}$$

$$\ln\sigma_2 = \ln K_2 + m\ln\dot{\varepsilon}_2 \tag{8}$$

By using the terms of equation (7) and equation (5), we gain n and K, in the following:

$$n = \frac{\ln\left(\frac{\sigma_1}{\sigma_2}\right)}{\ln\left(\frac{\varepsilon_1}{\varepsilon_2}\right)} \tag{9}$$

$$K_1 = \exp\left[\ln\sigma_2 - \frac{\ln\left(\frac{\sigma_1}{\sigma_2}\right)}{\ln\left(\frac{\varepsilon_1}{\varepsilon_2}\right)}\ln\varepsilon_2\right] \tag{10}$$

By the same way, m and K is obtained, in the following:

$$m = \frac{\ln\left(\frac{\sigma_1}{\sigma_2}\right)}{\ln\left(\frac{\dot{\varepsilon}_1}{\dot{\varepsilon}_2}\right)} \tag{11}$$

$$K_2 = \exp\left[\ln\sigma_2 - \frac{\ln\left(\frac{\sigma_1}{\sigma_2}\right)}{\ln\left(\frac{\dot{\varepsilon}_1}{\dot{\varepsilon}_2}\right)}\ln\dot{\varepsilon}_2\right] \tag{12}$$

3 Discussion

According to the above equations the curves will be obtained here as shown Figure 1. It has been the results by using the different parameters such as *n*,*m* and *K*. From Figure 1a) ~ Figure 1c) the curves of different *n* have been drawn, the low *n* and *K* will cause high stress that's saying low strain. The low *m* cause low stress ie high strain. In general, high *n* & *K* and low *m* cause low stress and high strain. These correspond with the above three conditions well. From Figure 1b) it is observed that the lowest stress with sensitivity m is proved too[2-3]. It explains *m* is the most sensitive factor in these three conditions. The baddest one is *n* it has high stress and low strain so that the low effect to plastic.the middle one is *K* it has been the secondary factor to plastic. So turn is listed as below *m*>*K*>*n* from the first to third factor. They have been investigated and find that the difference between these different value in the same parameter is to bigger with increasing strain to 550% which is superplastical field. It is slow increasing stress is formed within high strain. That explains the similar superplastics phenomenon to take place. So if we choose the fit value the superplasticity will be formed too, which is concluded in this paper. There are controlling the detail value to simulate the superplasticity. It will be done further research to study mechanism forming superplastic behavior in the future. From Figure 1a) in the point of 100% strain there are turning phenomenon ie. The usual role is formed beyond 100% that is the high strain field. This expresses the good coincidence with the other reports. Below this point the opposite role is done and what it will role true to need to further study. We analyze *n* is the factor to opposite role because it is bad effect one so that it may do opposite role to stress and strain curve by now. According to three superplastic conditions the m is the regulative factor in reports. Besides these the *K* and *n* have also a certain role in superplatic behavior which is conclusion from this paper.

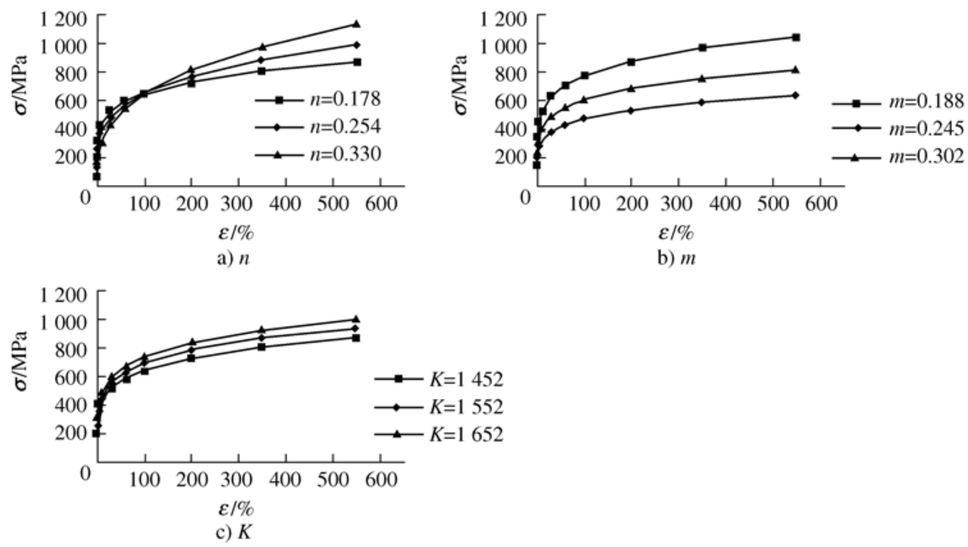

Figure 1 The curve of strain and stress on different parameters in Ti_3Al

The *m*>*K*>*n* is the found new turn in three parameters this paper as above. The effective factor is *m* sensitive which mainly regulates the stress size to attain the good ductility because the high stress results low strain as statistic other references. The high *m* sensitive exponent results in low stress and high strain including to big plasticity even superplasticity. The *m* above 0.2 will be available one shown in Figure 1a), the 0.178 causes low stress mostly while 0.33 results high mainly, and the 0.254 is the middle section to ductility. So that 0.15 above is excellent parameter to cause superplasticity. So the condition for comparing is adopted to search more is the future direction for us to proceed. Although *m* is main factor to regulate the superplasticity the *K* and *n* also need to be done to investigate their role in plastic behavior. As there known the *n* will play opposite role to plastic even super-plasticity phenomenon this function is studied more to demonstrate the opposite cause. When the strain is limited within 100% strain the *n* decreases strain so that *n* will be decreased to wield its strain. It is conquered to get more effective method to wield its role ie opposite function to regulate. Secondly, *K* is used to role a certain effect to gain the plastic is a new approach method found in here. Related studies need to be proceeded to find their respective function to improve the ductility disqualification problem.

4 Conclusions

1) $m>K>n$ is the found new turn in three parameters found in this research. *M* is a main factor to affect the ductility which default is a current main problem.

2) *n* will play opposite role to plastic when strain is below 100%. this function is studied further to demonstrate the opposite cause.

3) *K* is used to role a certain effect to gain the plastic is a new approach method secondly. If its function is satisfactory the well conclusion will be gained as expected.

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Brief Biographies

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