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Modelling of Parameters with K, K_2, N & M for Superplastic Deformation in TiAl Alloys

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Abstract

With regard to plasticity happened in Ti3Al and TiAl alloys the smaller n、m &K2 、K is to result in bigger one according to research in this paper. Here the bigger m may result in bigger plasticity, however when that plasticity indicates beyond this critical point with 100% the reverse one will happen that expresses the bigger m cause smaller plasticity. The stress provides less than usual for n & K. The reason for that may be considered to account for little value of them.

Keywords: Modelling； Parameter；K、K2、n & m, Ti3Al alloys; Superplastic deformation, TiAl alloy

Introduction

The superplastic deformation of Alloys is to lead to a good performance in failure situation. Such as the creep and tensile test, in this situation it can wield its toughness up to utmost. So the simulation is to be proceeded in advance for the sake of evaluating its synthetic ability of superplastic deformation. It will help to save manufacture cost and control the process and parameters like n、K & m in materials. In Ti3Al and TiAl alloys the plasticity has dominated in many fields as an important components in aeronautics. In some papers the conclusions are done as its function for causing ductility and high strength has provided good one. In China some institutions propose its detail application for future search project in aeronautic turbine blade part like Ti-25at.%Al-(12~22)at.%Nb alloys. Therefore, the detail narrate will be done for searching this alloys. Through the computation the stress and strain tendency is to be observed for us to discuss further. In this paper the equation between stress and strain, strain rate is to be used for exploring s and e, $\dot{\varepsilon}$ performance. Because this three parameters can affect the plasticity in literature, the simulation with formula will clarify certain problem where the destination is existed in. The lower m may increasing plasticity while the same n may increasing it as well where the conclusions has been arrived through this simulation with modelling their relationship in the end. Thereby, the super plastic deformation is to become the main destination by this paper at all where the respective parameters have been controlled through simulating the performance course [1-8].

Calculation and Discussions

Now the numerical model is built as below turns. For the tensile test course

In terms of equation $\sigma = K\varepsilon^n$ (1)

Take the logarithm it has $LN\sigma = LNK + nLN\varepsilon$ (2)

In terms of equation too $\sigma = K_1 \dot{\varepsilon}^m$ (3)

Here K is strength coefficient, MPa; K_1 is the same for strain rate, MPa; n is strain hardening exponent; m is strain rate sensitive coefficient; σ is the true flow stress, MPa; ε is the strain; $\dot{\varepsilon}$ is strain rate.

The same as above (2) it has

$LN\sigma = LNK_1 + mLN\dot{\varepsilon}$ -----(4)

from （1） & （2） it gains below two equations

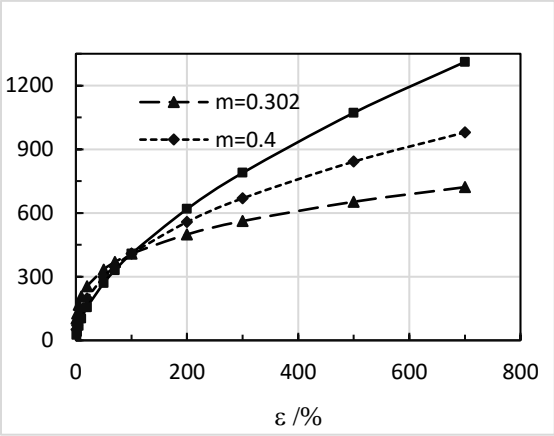
$$n = \frac{LN(\sigma_1/\sigma_2)}{LN(\varepsilon_1/\varepsilon_2)} \text{ ----- (5)}$$

$$K = EXP[LN\sigma_2 - \frac{LN(\sigma_1/\sigma_2)LN\varepsilon_2}{LN(\varepsilon_1/\varepsilon_2)}] \text{ ----- (6)}$$

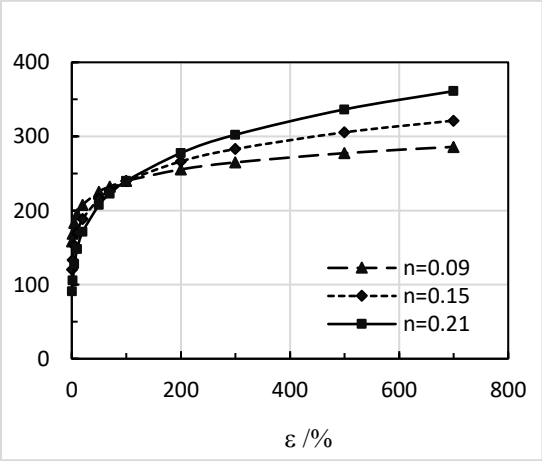
$$m = \frac{LN(\sigma_1/\sigma_2)}{LN(\dot{\varepsilon}_1/\dot{\varepsilon}_2)} \text{ ----- (7)}$$

$$K_1 = EXP[LN\sigma_2 - \frac{LN(\sigma_1/\sigma_2)LN\dot{\varepsilon}_2}{LN(\dot{\varepsilon}_1/\dot{\varepsilon}_2)}] \text{ ----- (8)}$$

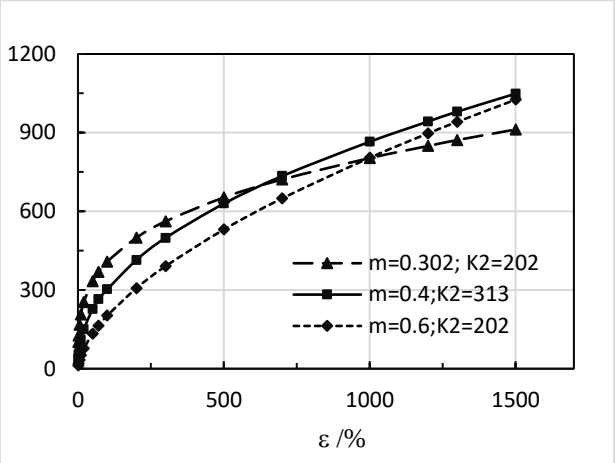
Those (5-8) equations are the parameters resolution in tensile test. From (3) & (4) those two equations is to be gained for below results as well. The m to be 0.302~0.6, K to be 240MPa~440MPa and n to be 0.09~0.21 is to be chosen for simulating the deformation of Ti-Al alloys in this paper. The conclusion with each stress and strain may be narrated as below in details and discussed respectively.



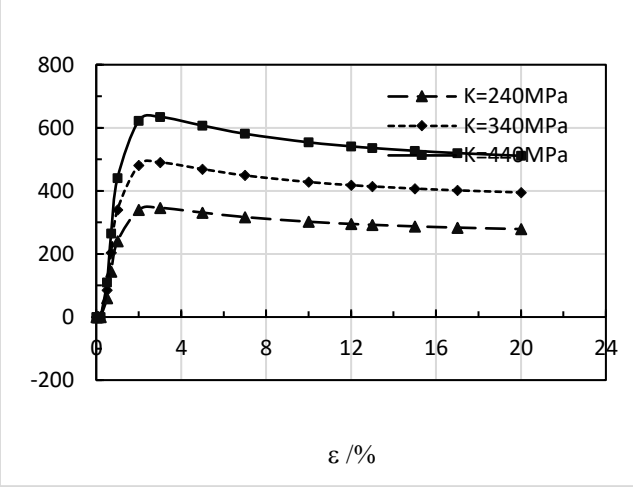
a) m



b) n



(c) m &K_2



d) k

Figure 1: *The relationship between σ (MPa) and e with m、n &K2、K in the Ti-Al alloys.*

For the sake of controlling those K, m &n the respective stress curve has been drawn as following ones according to the above results. In Figure 1(a~d) the stress is to be lower with m lowering, meantime it is to be the same with lowering n as shown in Figure 1(a & b) correspondingly. If m=0.302 and n=0.09 the stress may be lowest. As the m and n enhances the one may increase. In Figure 1(c &d) the stress may be low with lowering m and K2, meanwhile, the stress may be low too with lowering K respectively. In details when m=0.302 and K2=202MPa the lowest stress may be provides. When K=240MPa the lowest one may be formed with 340MPa where it means the highest plasticity may be acquired with it. Here the m is to transform into reverse tendency according to Figure 1(a) when the strain changes to exceed 100% where it may be explained that the bigger m results in small strain after passing this one correspondingly. As literature [9] the bigger m may result in bigger plasticity however when that plasticity not beyond this critical

point with 100% the reverse one will happen in this paper. At the same time, from Figure 1(b &d) it is observed that the stress provide little than usual. The reason for that may be considered is to account for little one of them. In Figure 1(d) it is to be supposed that parameter n=1/e in this paper for deducing super plasticity.

Conclusions

The stress is to be lower with lowering m, n & K2, K which expresses that the higher strain may be formed. When K=240MPa the lowest one may be formed with 340MPa. The bigger m may result in smaller plasticity however when that plasticity indicates beyond this critical point with 100% the reverse one will happen. The stress provide little than usual for n and K. The reason for those may be considered to account for little one of them.

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