Model for m & Stress and Strain Rate of Superplastic Deformation in Ti$_3$Al Alloys

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Abstract: The superplastic behavior is built to analyze the phenomenon of Ti$_3$Al. Through parameter change of stress, elongation & $K_m$ and flow stress is acquired. Through comparing with their value size it is found that stress and $K$ will play an important role to $m$ and flow stress respectively. Furthermore they are relationship in proportion to strain rate.

Keywords: model; superplastic deformation; m & flow stress; strain & $K$; Ti$_3$Al

1. Introduction

The relationship between strain rate sensitive exponent $m$ & flow stress and strain rate in Ti$_3$Al has not been systematically studied so far, so this paper calculates and compares the relationship among them to explore the mechanism of super plasticity. [1, 2] The $m$ increases will cause even super plasticity. The turn of effective plasticity is $m>K>n$. furthermore strain rate and $m$ & stress will Express this important parameter how it has relationship with super plasticity important parameter $m$ and flow stress. Only if the parameter of strain rate is clarified can we determine other parameters for instance strain rate exponent $m$ and flow stress value to find whether this super plasticity can form or not. We know that low flow stress will result in high plasticity. On the other hand high $m$ will result in super plasticity if $m > 0.5$ [3]

![Graph 1](image1.png)

(a) $m/\sigma$

![Graph 2](image2.png)

(b) $m/K$
2 Model research

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  \( \ln \sigma = \ln K + n \ln \varepsilon \) -- (2)

In terms of equation too  \( \sigma = K_1 \varepsilon^m \) -- (3)

Here K is strength coefficient; n is strain hardening exponent; m is strain rate sensitive coefficient.

The same as above (2) it has

\[ \ln \sigma = \ln K + m \ln \varepsilon \] -- (4)

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

\[ n = \frac{\ln(\sigma_i / \sigma_2)}{\ln(\varepsilon_i / \varepsilon_2)} \] -- (5)

\[ K = \exp(\ln \sigma_2 - \frac{\ln(\sigma_i / \sigma_2) \ln \varepsilon_2}{\ln(\varepsilon_i / \varepsilon_2)}) \] -- (6)

from (3) & (4) we gain below two equations too

\[ m = \frac{\ln(\sigma_i / \sigma_2)}{\ln(\varepsilon_i / \varepsilon_2)} \] -- (7)

\[ K_1 = \exp(\ln \sigma_2 - \frac{\ln(\sigma_i / \sigma_2) \ln \varepsilon_2}{\ln(\varepsilon_i / \varepsilon_2)}) \] -- (8)

These (5-8) equations are the parameters resolution in tensile test.

2. Discussion & conclusions

As shown in Figure 1 (a, b) it shows that with the increasing strain rate \( \varepsilon \) the m increases. Meantime with the increasing stress \( \sigma \) and K m also increases as well. Through observation it has been found that K can play leading role to flow stress. Figure 1 (c, d) it shows that with the increasing strain rate \( \varepsilon \) the stress also increases while with the increasing elongation \( \varepsilon \) and K m increases too, which is another observation in this paper.

3. Conclusions

1. M value increases with the increase of K and stress. The stress plays a role to m in flow stress.

2. With the increase of elongation and K increases, stress decreases, indicating that K plays a role in increasing plasticity.

References


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