EFFECT OF SIC PARTICLE SIZE ON DYNAMIC RECRYSTALLIZATION CRITICAL STRAIN

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ABSTRACT

Using Gleeble-1500D simulator, the dynamic recrystallization behavior of 30%SiCp/Al composite with different SiC particle size were investigated at 350-500℃ with strain rate of 0.01-10s^{-1}. The results show that the softening mechanism of the dynamic recrystallization is a feature of high-temperature flow stress-strain curves of the composite. Based on the true stress-strain curves, $\ln\theta$-ε and $(-\partial(\ln\theta)/\partial\varepsilon)-\varepsilon$ curves were plotted based on the experimental data to further obtain the critical strain and steady strain of DRX. The critical strain increases with the increase of strain rate and the reduction of deformation temperature, there is linear relationship between critical strain and peak strain, while the critical strain increased with increasing *Z* parameters, a function of the relationship between the critical strain and *Z* parameters were obtained. Dynamic recrystallization critical strain model of SiCp/Al composites were established. With the decrease of the SiC particle size, the critical strain occurs in advance.

1 INTRODUCTION

Dynamic recrystallization (DRX) is an important mechanism for the microstructure control during hot deformation, which plays a major role in reducing the grain size and is a powerful tool for controlling mechanical properties during industrial processing, so the understanding of the hot deformation behavior is essential. The purpose of this study is to understand the effect of SiC particle size on Dynamic recrystallization critical strain of 30%SiCp/Al composite.

2 EXPERIMENTAL MATERIALS AND PROCEDURES

The 30vol.%SiCp/2024Al composite was produced through the PM route.The 2024Al powders (Al-3.8wt.%Cu-1.5wt.%Mg), with an average diameter of 10 μm, were blended with a volume fraction of 30%SiC particles (with a nominal size of 8,15and 40 μm) for 24h

Cylindrical compressive specimens 8 mm in diameter and 12 mm in height were machined from those hot-pressing-sintered billets. In order to minimize the coefficient of friction during hot compression testing, machine oil mixed with graphite powder were used for lubrication. Uniaxial compression tests were conducted in the temperature range of 350-500℃ (in step of 50℃) and the strain rate of 0.01-10s-1, utilizing Gleeble-1500D simulator to achieve isothermal constant strain rate deformation. After straining, specimens were quenched within two seconds to preserve the hot worked microstructures.

3 RESULTS AND DISCUSSION

Dynamic recrystallization critical strain model of SiCp/Al composites were established. At a constant initial grain size, the constitutive equations of peak and critical strains are usually shown as power-law functions of *Z* in the form of which is proposed by Sellars

$$\varepsilon_c = aZ^b$$

where *a* and *b* are constants. Fig.1 illustrates the relationship between natural logarithm of the calculated strain and natural logarithm of the Zener-Hollomon parameter. It is clear that the value of $\ln\varepsilon_c$ increases with the increase of Zener-Hollomon parameter. Furthermore, it is obvious that the relationship between

lnε_c and ln$Z$ can be approximated by a group of parallel and straight lines under the hot deformation conditions.

The relationship between ε_c and ε_p .ε_c and Z of different SiCp/Al composites were shown table 1.With the decrease of the SiC particle size, the critical strain occurs in advance.

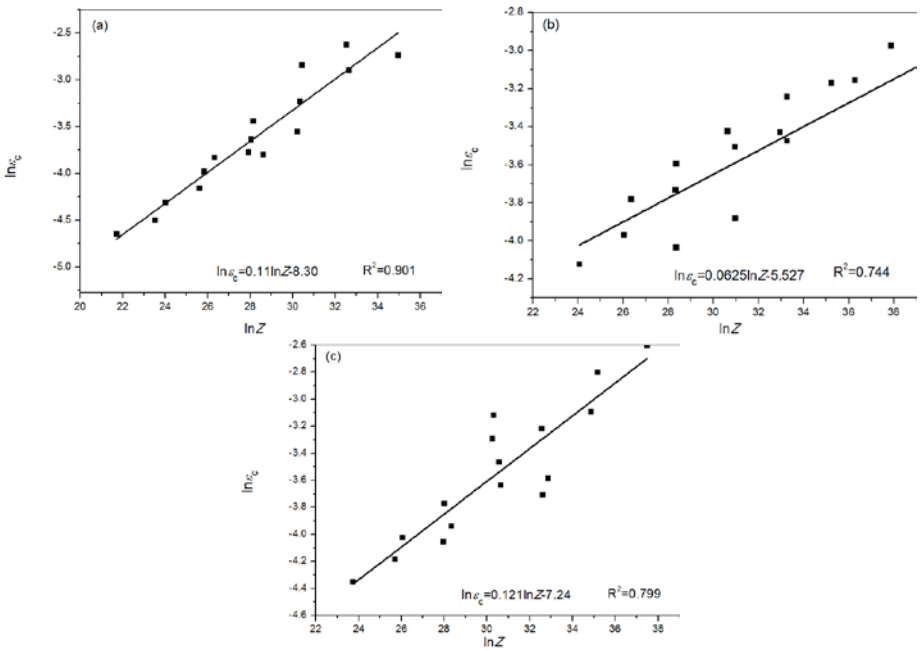

Figure 1 Relationship of lnε_c and lnZ of different SiCp/Al composites (a)30%SiCp(8μm)/Al;(b)30%SiCp(15μm)/Al;(c)30%SiCp(40μm)/Al

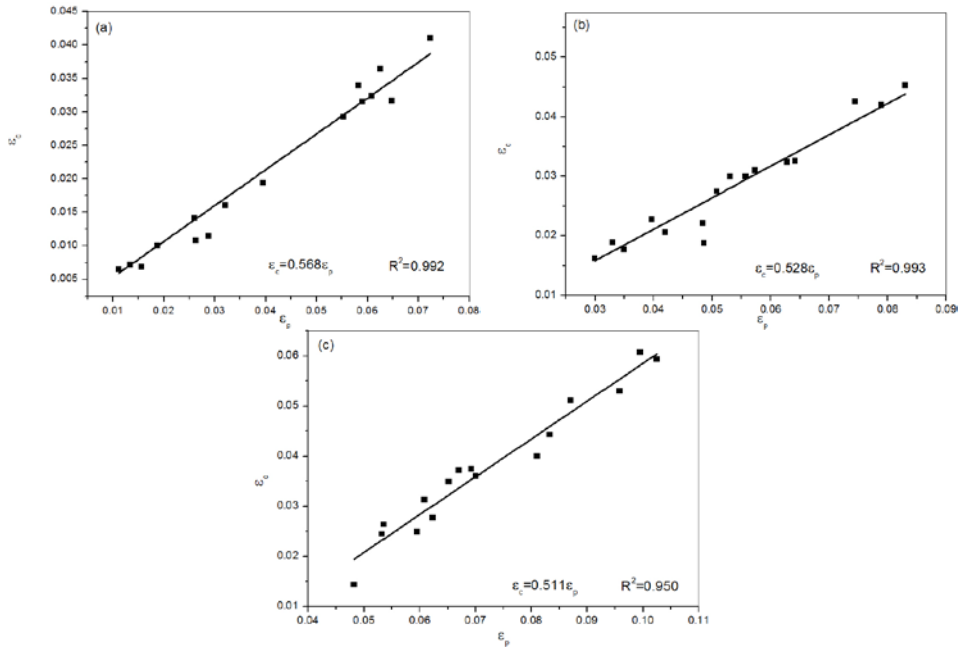

Figure 2: The relationship between ε_c and ε_p of different SiCp/Al composites (a)30%SiCp(8μm)/Al;(b)30%SiCp(15μm)/Al;(c)30%SiCp(40μm)/Al

Table 1: Relationships between ε_c and ε_p, ε_c and Z of different SiCp/Al composite

Materials	$\varepsilon_c/\varepsilon_p$	Relationships between ε_c and Z
30%SiCp(8μm)/Al	0.511	$\varepsilon_c=7.17\times10^{-4}Z^{0.12}$
30%SiCp(15μm)/Al	0.528	$\varepsilon_c=3.98\times10^{-3}Z^{0.06}$
30%SiCp(40μm)/Al	0.568	$\varepsilon_c=2.49\times10^{-4}Z^{0.11}$

4 CONCLUSION

Hot compression tests on 30%SiCp/Al composite were performed with different SiC particle size in different deformation conditions. The stress-strain data were carefully analyzed. The following conclusions can be drawn:

(1) The main softening mechanism of 30%SiCp/Al composite during the thermal deformation is dynamic recrystallization mechanism.

(2) The critical strain for initiation of dynamic recrystallization can be identified from the inflection point on the strain hardening rate versus flow stress curve. The critical strain increases with the increasing strain rate and the decreasing deformation temperature, there is linear relationship between critical strain and peak strain.

(3) The initial critical strain of dynamic recrystallization can be calculated by Sellars model setting, and there is a relationship between ε_c and *Z*.

(4) With the decrease of the SiC particle size, the critical strain occurs in advance.

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