In-situ texture determination during phase transformation treatment of rolled sheets with diffusional and non-diffusional transformation

1. Introduction

In general, sharp phase transformation texture will not appear when variant selection is absent. However, deformation can promote variant selection during phase transformation treatment and reinforce phase transformation texture. At present, strong transformation texture of <11-20>//ND is obtained in pure Ti sheets obeying Burgers relationship by cold rolling and phase transformation annealing. However, there is still a lack of texture information at high temperatures for analysis of variant selection during phase transformation. For high-manganese TRIP steel, the goal of experiment is to distinguish the rolling texture and TRIP-induced phase transformation texture. The goal of Ti is to clarify the texture evolution and phase transition in the α→β→α phase transformation process, and the most important is the texture information at high temperature.

2. Experiment

For the first experiment, high-manganese TRIP steel with a composition of Fe-0.0024 C-18 Mn-3 Si-1.5 Al (wt%) was used in this study. Ingot was heated at 1323 K for 1.5 h and water-cooled. The material was then cold rolled with 10%, 20%, 40%, 60%, 80% and 90% respectively. Samples 6 mm × 60 mm were cut from the different cold rolled sheets and measured at room temperature. For the second experiment, cold-rolled commercial pure titanium sheet was used in this study. The measuring temperatures during heating are at 800 °C and 950°C, respectively, and during cooling, the measuring temperatures are at 870 °C and 800 °C, respectively. The data of pole figures, ODF and volume fractions of different phases need to be obtained.

3. Results

The volume fractions of γ, ε-M and α′-M phases and their textures of 10%, 20%, 40%, 60%,80% and 90% cold rolling reductions at room temperature are shown in Figure 1 and Figure 2 respectively. It is shown that the TRIP effect mainly occurs before 60% cold rolling reduction. And the contents of three phases tend to be stable under higher reduction. Concerning the PF results, it is possible to observe that the cold-rolled texture of the γ presents a strong brass component which is usual for austenite intensely deformed. The main component in α'-M is rotated cube ({001}<110>) texture at 20% and 40% cold rolling reduction, and the {001}<110> texture rotates toward {111}<110> and {112}<110> texture with 60% reduction, and eventually come into being a more stable orientation {111}<110> with increasing reduction. Research shows that the α'-M formed by phase transformation of γ grains with brass orientation has {554}<255>、{332}<113> and rotated cube orientation. Therefore, the strain induced martensitic transformation take place in γ with brass texture and α'-M forms typical {001}<110> phase transformation texture at medium cold rolling reduction. And a higher reduction results in dominantly the deformation of α'-M and leads to a strong {111}<110> cold rolling texture.

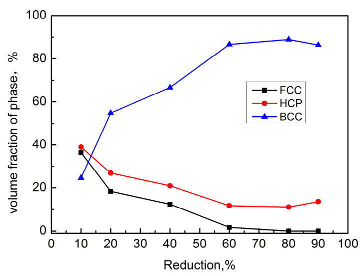

Figure 1. Volume fractions of γ, ε-M and α′-M phases in cold rolled high manganese TRIP steel at different reductions.

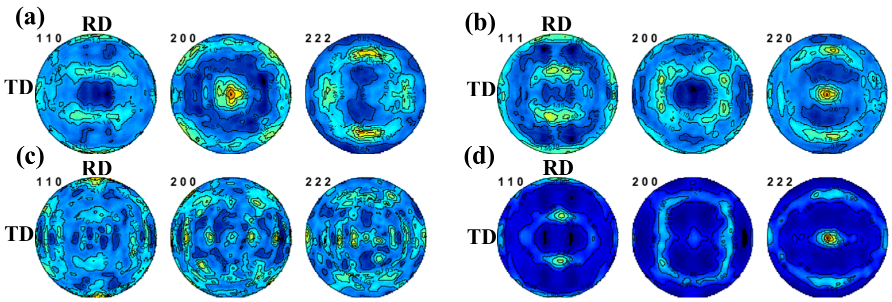

Figure 2. Pole figures of γ and α′-M phases in cold rolled high manganese TRIP steel, **(a)** γ phase at 20% reduction; **(b-d)** α′-M phase at 20%, 60% and 90% reductions, respectively.

For the second experiment, as is presented in Figure 3, the texture of the cold-rolled sample was a basal texture with a 30° rotation around the rolling direction. The similar texture of the 30° rotated basal component was retained at the heating 800°C, slightly different is [10-10]//RD changes to [11-20]//RD. The results of the texture at 950°C are presented in Figure 3c, suggesting a {112} <11-1> and {110} <1-10> texture for the high temperature. At cooling 870°C, two phases exist at the same time, and the texture of α and β phases are similar to the texture of heating 800°C and 950°C sample, respectively. Further, I can determine the starting and ending points of the phase transition at cooling through this experiment, which are 896°C and 836°C respectively. After the α→β→α phase transformation, the texture of the annealing sample at cooling 800°C was mainly composed of a 30° rotated basal texture that was similar to the heating 800°C sample. Texture inheritance occurred subsequently to the phase transformation.

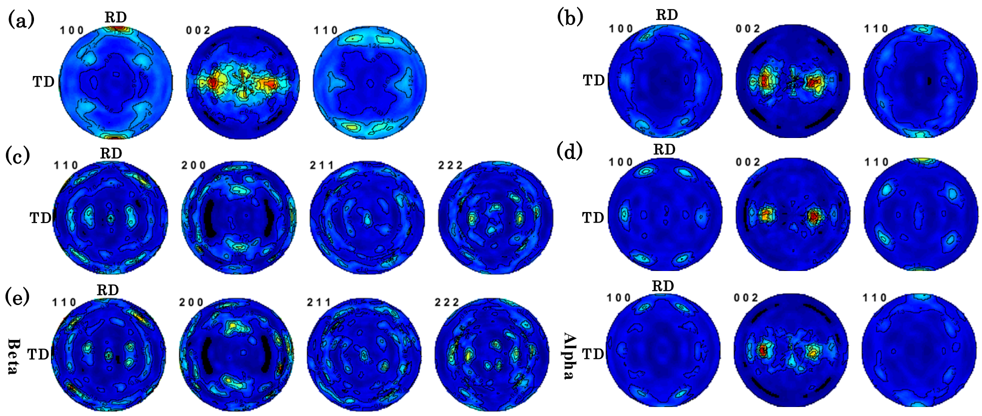

Figure 3. Pole figures of 80% cold-rolled TA2 sheet with 0.8 mm thickness measured at different annealing temperatures, **(a)** 25°C; **(b)** heating 800°C; **(c)** 950°C; **(d)** cooling 800°C; **(e)** cooling 870°C

4. Conclusion

(1) The γ is almost completely transformed into α′–M at medium cold rolling reduction and the main component in α′-M is rotated cube ({001}<110>) texture, which is the typical phase transformation texture. And the contents of three phases tend to be stable under higher reduction. The {001}<110> texture rotates toward a more stable orientation {111}<110> and lead to a strong {111}<110> cold rolling texture with increasing reduction.

(2) The texture of the sample at 950°C was {112} <11-1> and {110} <1-10> texture. The starting and ending points of the phase transition at cooling are 896°C and 836°C respectively. Texture inheritance occurred in the α→β→α phase transformation.