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Recrystallization textures of the M{1 1 3}⟨1 1 0⟩ and P{0 1 1}⟨4 5 5⟩ orientations in a supersaturated Al–Mn alloy

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The evolution of recrystallization texture in a supersaturated Al–Mn alloy was investigated by X-ray diffraction. A new recrystallization texture {1 1 3}⟨1 1 0⟩ was found in this alloy in addition to the P recrystallization texture. The formation of the M and P recrystallization textures depended strongly on annealing temperature. Low-temperature annealing of the cold-rolled sheets resulted in strong M and P recrystallization textures. The strength of the M and P recrystallization textures decreased with increasing annealing temperature.
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Recrystallization texture has long been a subject of research by metallurgists since it is one of the main factors responsible for the anisotropy of mechanical properties of final sheet products. The recrystallization texture of most aluminum alloys is characterized by the cube orientation with some scatter about the rolling direction towards the Goss orientation. However, annealing of deformed, supersaturated AA 3000 series aluminum alloys usually results in different recrystallization textures due to the effect of concurrent precipitation [1–5]. Nes and co-workers [1,2] investigated the recrystallization texture of AA 3000 series aluminum alloys. They found that concurrent precipitation resulted in relatively strong P{0 1 1}⟨4 5 5⟩ and ND-rotated cube {0 0 1}⟨3 1 0⟩ textures in commercial Al–Mn–Mg [1] and AA 3103 [2] alloys. Moreover, a very strong P recrystallization texture was also observed in continuous cast (CC) AA 3004 [3] and AA 3015 [4,5] aluminum alloys. The formation of the P texture depended strongly on annealing temperature [5]. In the present study, the hot band of CC AA 3003 aluminum alloy was directly cold-rolled to 90% reduction. The evolution of recrystallization texture in the cold-rolled CC AA 3003 aluminum alloy was investigated.

The chemical composition of the CC AA 3003 aluminum alloy is given in Table 1. In CC processing, the molten metal is poured between two rotating steel belts to produce a cast slab, and then the slab is immediately fed into three consecutive hot rolling mills, forming hot band products. CC hot bands retain a large amount of alloying elements in solid solution due to the rapid cooling rate of the CC slab. In order to investigate the recrystallization texture in the supersaturated aluminum alloy, the as-received hot band with a thickness of 2.55 mm was cold-rolled to 90% reduction, and then annealed at different temperatures for various lengths of time in a salt bath, followed by water quenching.

Texture measurements were performed at the quarter thickness of the cold-rolled and annealed sheets. The (1 1 1), (2 0 0) and (2 2 0) pole figures were measured up to a maximum tilt angle of 75° by the Schulz back-reflection method using Cu K_α radiation. The orientation distribution functions (ODFs) were calculated from the three incomplete pole figures using the series expansion method ($l_{max} = 16$) [6]. The ODFs were presented as plots of constant φ_2 sections with isointensity contours in Euler space defined by the Euler angles φ_1, Φ and φ_2.

The progress of recrystallization was studied by measurements of hardness HV as a function of annealing

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Table 1. Chemical composition of CC AA 3003 aluminum alloy (wt.%)

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Al
0.206	0.575	0.155	0.988	0.035	0.022	0.065	0.015	Bal.

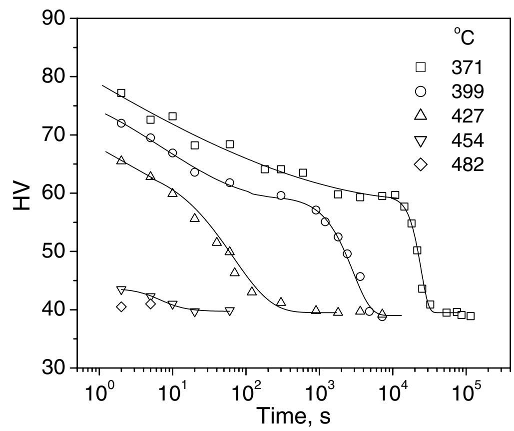

Figure 1. Hardness of CC AA 3003 aluminum alloys as a function of annealing time at different temperatures.

time at different temperatures. Figure 1 shows the variation in hardness with annealing time for the cold-rolled CC AA 3003 aluminum alloy. After a minor hardness decrease due to recovery effects, the hardness substantially decreased, indicating the occurrence of primary recrystallization.

Figures 2–4 show the texture evolution of the cold-rolled CC AA 3003 aluminum alloy during isothermal

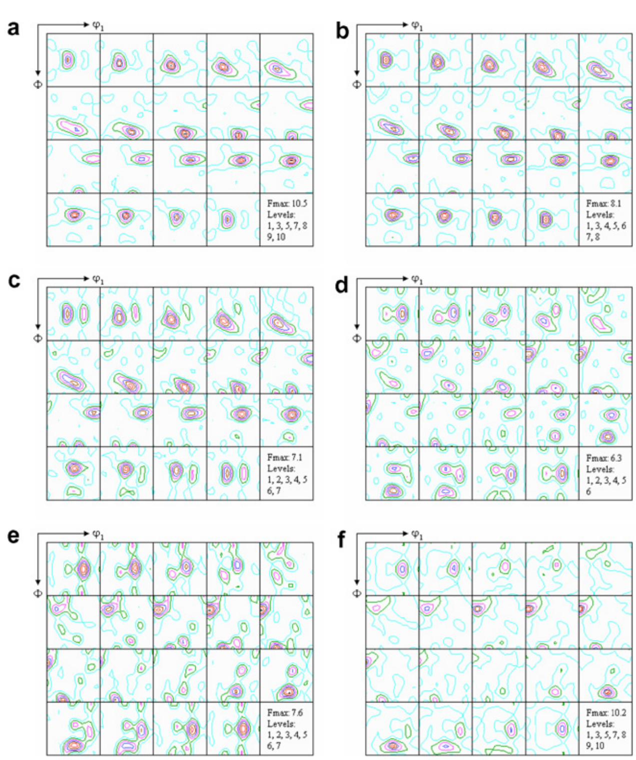

Figure 2. ODFs of cold-rolled CC AA 3003 aluminum alloy after annealing at 371 °C for (a) 3 h, (b) 6 h, (c) 7 h, (d) 9 h, (e) 15 h and (f) 32 h.

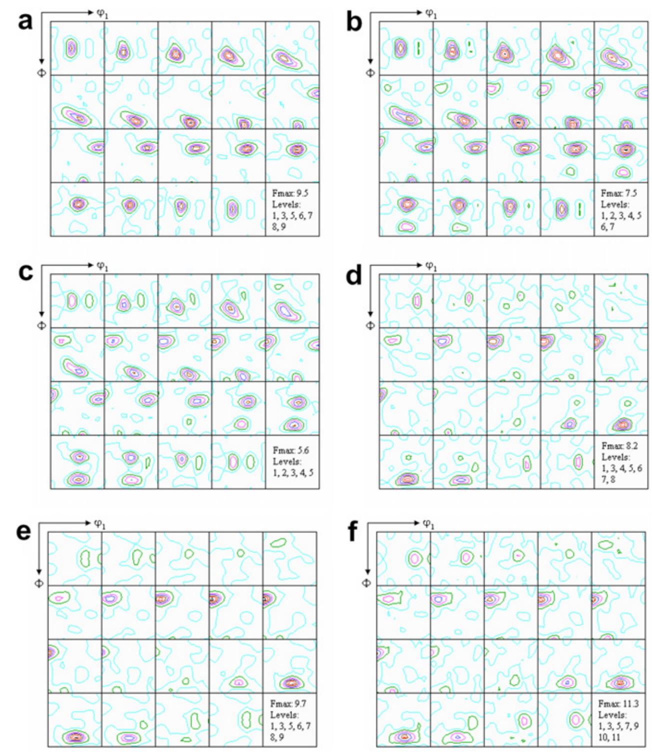

Figure 3. ODFs of cold-rolled CC AA 3003 aluminum alloy after annealing at 399 °C for (a) 15 min, (b) 30 min, (c) 40 min, (d) 1 h, (e) 2 h and (f) 3 h.

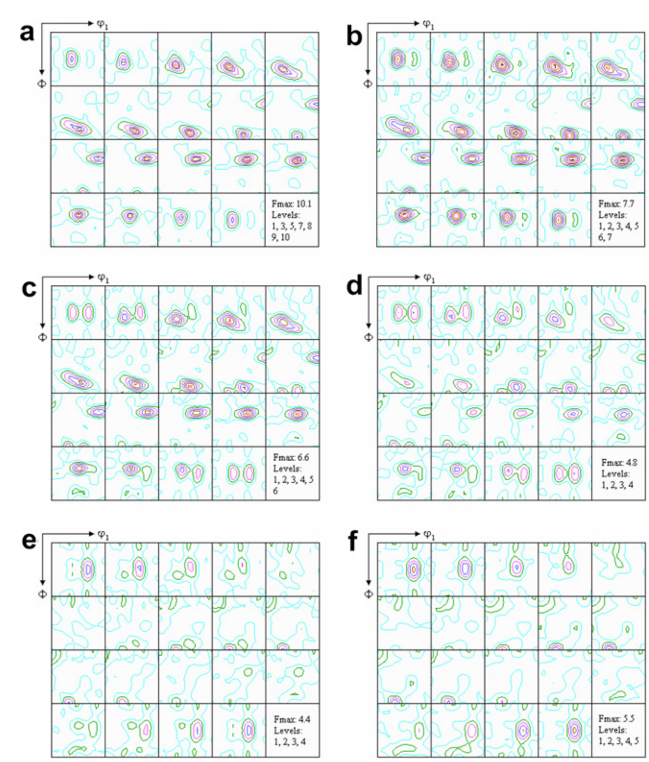

Figure 4. ODFs of cold-rolled CC AA 3003 aluminum alloy after annealing at 427 °C for (a) 2 s, (b) 10 s, (c) 20 s, (d) 40 s, (e) 2 min and (f) 15 min.

annealing at 371, 399 and 427 °C, respectively. It is noted that the evolution of recrystallization texture

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