LETTERS TO THE EDITOR

Development of $\langle 111 \rangle$ Fibre Texture in α -Fe through the Diffusional Process without γ - α Transformation

In early work⁽¹⁾ the authors reported that the diffusion of zinc into iron gave rise to columnar grains of α -iron with a $\langle 111 \rangle$ fibre texture and discussed the formation mechanism of this texture on the supposition that it was developed by the accompanying γ to α transformation. Further experiments have revealed, however, that the texture is formed actually without phase transformation and that the transformation brings about rather no preferred orientations, as described in the present report.

An Fe-Zn specimen was prepared by annealing a sheet specimen of iron and chips of zinc which were placed at each end of a fused silica tube evacuated. In the present experiment the zinc chips were kept at a sufficiently low temperature until the iron sheet reached 930°C so that the α -phase was transformed from the γ -phase by the diffusion of zinc. In the previous study⁽¹⁾, however, zinc chips and an iron sheet were heated in parallel and consequently the diffusion of zinc into α -iron that took place during heating must, when inferred from the results obtained in the present work, have resulted in keeping away from the α to γ transformation in accordance with the phase diagram⁽²⁾. Fe-Al specimens were prepared by annealing an iron sheet embedded in Fe-Al alloy powder in a fused silica tube evacuated, i.e. by the essentially same method as applied by Nishida, Yamamoto and Nagata⁽³⁾.

The X-ray diffraction intensities from the sheet surface measured by the Schulz technique in the reflection mode are shown in Fig. 1 as reported previously⁽¹⁾.

The solid lines in the figure demonstrate that the $\langle 111 \rangle$ fibre texture was developed in the relevant Fe-Al specimen. This texture was observed in all the other specimens of Fe-Al alloys annealed below the A_3 temperature. The broken line shows, on the other hand,

Fig. 1 Pole density distribution curves. Fe-Zn was annealed for 150 h at 1000°C and Fe-Al for 50 h at 850°C.

that no preferred orientation was formed in the Fe-Zn specimen after the zinc-diffusion induced γ to α transformation.

Yamamoto, Sakuma and Nishizawa⁽⁴⁾ reported also that the γ to α transformation of iron induced by the diffusion of chromium, tin and antimony did not develop a preferred orientation. In the case of decarburization of the austenite in the Fe-C system⁽⁵⁾⁽⁶⁾ as well as of enrichment of the zinc concentration in the Cu-Zn system⁽⁴⁾⁽⁷⁾, however, preferred orientations were formed through the diffusion induced phase transformation.

The exact mechanism of this preferred orientation development in the diffusion layer without phase transformation is still unknown. But it must be related to the stress⁽⁸⁾ in the diffusion layer induced by the Kirkendall effect and the lattice parameter gradient accompanied by the concentration change. The

stress is reported to cause plastic deformation resulting in the formation of characteristic subboundary structures^{(9)~(11)} and even in recrystallization⁽¹²⁾.

The $\langle 111 \rangle$ fibre texture in the diffusion layer of α -iron may be therefore attributed to the preferential formation of $\langle 111 \rangle$ oriented recrystallization grains presumably associated with anisotropical dislocation arrays caused by the diffusion induced stress. This stress will also take part in texture formation through the diffusion induced phase transformation, although it was not referred to in the previous work⁽⁵⁾⁽⁷⁾.

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(Received May 30, 1979)