Abstract

Cold rolled wire not only has good surface quality and high dimensional accuracy, but also has better microstructure and properties. The reasonable control of cold rolling deformation and heat treatment can not only easily meet the requirements of users for processing quality and comprehensive performance, but also be particularly beneficial to the production of some important products requiring special structure and performance[1].

Table 1 Technology for heating processing for Dia. 4.0mm TC16 alloy with the two Processing method

| Processing method | Heat-treated states | Heat-treatment |
|-------------------|---------------------|----------------|
| Cold tandem rolling | M                  | 780℃/2h/F 550℃/AC |
|                    | S                  | 800℃/2h/W 550℃/BF/AC |
| Hot-draw           | M                  | 780℃/2h/F 550℃/AC |
|                    | S                  | 800℃/2h/W 550℃/BF/AC |

3. Results and Discussion

Emergency contact of uniaxial microstructure and properties

This 0.40mm wire was obtained by 0.65mm billet through 5 pass rolling. Fig. 1 shows the transverse and longitudinal microstructures of the 0.40mm wire sample after heating for 2 hours at 780℃ and then cooling at furnace temperature to 550℃. Although dynamic recovery exists in the process of hot drawing at two-phase temperature, the drawing deformation is a gradual transition from the edge to the center of the wire, and the amount of inter-pass deformation is small, so the original longitudinal elongation of phase microstructure can be effectively maintained at room temperature, and the obtained longitudinal microstructure after annealing has an equiaxed phase state, as shown in FIG. 1(b).

This 0.40mm wire was obtained by 0.65mm billet through 10 pass rolling and 2 pass finishing rolling. Fig. 2 shows the transverse and longitudinal microstructure of the 0.40mm wire sample after heating for 2 hours at 780℃ then cooling with furnace temperature to 550℃. Compared with the drawing, cold tandem rolling has more severe deformation. The original longitudinal elongation of phase microstructure can be effectively maintained at room temperature, and the obtained longitudinal microstructure after annealing has an equiaxed phase state, as shown in FIG. 2(b).
The tensile properties of TC16 titanium alloy Φ4.0mm wire, which were processed by cold tandem rolling and hot drawing methods respectively after same annealing were analyzed. The contrast shows that TC16 titanium alloy wires tensile strength and yield strength of cold tandem rolling are lower than that of hot drawing, but the plasticity is better than that of hot drawing.

2.2 Cold heading forming properties of wire in two processing methods

The TC16 titanium alloy Φ4.0mm wire, which were processed by cold tandem rolling and hot drawing methods respectively after same annealing were carried out in accordance with the HB/815-2002 hexagon head bolts in titanium alloy TC16 with tolerance H7 to cold heading Φ4.0x20 mm fasteners, eventually cold heading fasteners, as shown in FIG.5.

The cold heading process of fasteners is a composite forming method in which upsetting and extrusion are combined. Whether cold heading can be successfully achieved requires not only the plasticity of the material at room temperature, but also the longitudinal microstructure of the material.[12-14]

The longitudinal elongated microstructure is less compatible with the longitudinal basket microstructure and the longitudinal lamellar microstructure during cold heading deformation. Compared with the longitudinal basket and the longitudinal lamellar microstructure, the longitudinal microstructure is less changeable in the process of cold heading deformation. Therefore, for TC16 titanium alloy wire used in cold heading, the longitudinal wire with elongated microstructure is more likely to crack during cold heading forming, while the fine equiaxed microstructure and net basket microstructure are conducive to cold heading forming.[10,14]

3.3 Comparison of microstructure and properties in solution aging state

For two kinds of processing methods of TC16 titanium alloy wire samples according to the 800℃/2h, WQ+560℃/8h, AC respectively at the same time to carry on the solid solution aging treatment. The horizontal and vertical microstructures of the two groups were compared and observed, as shown in FIG.8.
The TC16 titanium alloy wire produced by cold tandem rolling process has lower tensile and yield strength than that of hot-drawn wire, which is manifested as higher tensile strength, yield strength and shear strength. The processing method of cold tandem rolling has positive significance for the TC16 titanium alloy which needs to be strengthened by heat treatment for the finished fasteners.

4. Conclusion

(1) The transverse and longitudinal microstructure of hot-drawn wire is composed of equiaxed α phase and needle-like phase. Cold tandem rolling process can effectively break the original longitudinal structure and obtain the alloy wire with equal α phase in both transverse and longitudinal direction.

(2) After solid solution aging treatment, the strengthening effect of TC16 titanium alloy wire processed by cold tandem rolling is more obvious after the solid solution aging treatment, especially the tensile strength, yield strength and shear strength of the wire are higher than that of hot drawing processing.

5. Reference

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