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The Effect of Homogenization on the Microtexture of Drawn OFHC Copper

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Engineering properties of metals and alloys can be optimized by a combination of thermo-mechanical processes. In most cases, suppression of recrystallization and/or abnormal grain growth is desired. Industrial control of recrystallization mainly focuses on control of texture for formability, control of grain size and degree of recrystallization for surface appearance and damage related properties. One of the heat treatments carried out to improved workability [1] and mechanical properties [2] of most alloys is homogenization. This is principally performed to homogenize the heterogeneous microstructure [1] and texture [3] of the alloy for improved formability. Wire drawing is one of the industrial processes which are characterized by inhomogeneous microstructure and texture [4]. Despite the paramount importance of the homogenization process, little has been published on the effect of homogenization on the microstructure and texture of drawn wires. The present investigation was carried out to evaluate the effect of homogenization on the microstructure and texture of cold drawn OFHC copper wire.

The investigation was carried out on OFHC Copper wire, drawn at room temperature to a true strain of 2.31 (denoted as *D*), and homogenized at 400°C for 1hr (*S*), 5hr (*M*) and 15hr (*L*). The four specimens were then additionally annealed at 750°C for 1 hr (specimens denoted as *DH*, *SH*, *MH*, and *LH*, respectively). The additional annealing was done in order to assess the stability of the microstructure and texture after homogenization. All specimens were mechanically polished and etched by swabbing for about 15s with an equal amount of ammonium hydroxide (NH_4OH) and hydrogen peroxide 3% (H_2O_2). Microstructural measurements were performed using the electron backscattered based orientation imaging microscopy (OIM) technique in Environmental Scanning Electron Microscope (ESEM) model E3.

Figure 1 presents the microtexture of the wires, in the form of inverse pole figures (crystallographic planes parallel to drawing direction), after deformation and homogenized at 400°C. The microtexture of the drawn wire (*D*) consisted of a duplex major<111>+ weak<100> fiber texture. Upon annealing at 400°C for 1hr (*S*), the wire recrystallized with a distinct major<100>+weak<111> fiber texture. This reversal in the texture is typical of most fcc metals [5]. Although the recrystallization texture persisted at 5hr (*M*) and 15hr (*L*), it is evident that prolonged annealing slightly enhanced the intensity of the <100> component. Isothermal annealing at 750°C for 1hr resulted in another reversal in the texture as shown in Figure 2. In this case, the strong<100>+weak<111> in samples *DH* and *SH* completely changed to a near <111> fiber texture. On the other hand, sample *MH* exhibited a fiber texture of roughly equal fractions of <111> and <100> components, with a minor <112> component, and sample *LH* developed a major <111>+ <112> components, with a minor <100> component. This second texture transition from the <100> dominated recrystallization texture to the <111> dominated growth texture is due to secondary recrystallization, which favors the <111> orientation at the expense of the <100> component [5]. This is illustrated in Figure 3 which shows that the grain sizes of the <100> and <111> components were fairly the same in the as-drawn sample (*D*) and homogenized samples (*S*, *M*, and *L*). However, annealing at 750°C produced dramatic differences in the grain sizes of the two major components. While the ratio of grain size of <111> to <100> was 3.5 in sample *DH*, this ratio was reduced roughly to 1 in samples *MH* and *LH*. Thus, prehomogenizing the wire for a sufficient period of time (t ≥ 5hrs) inhibited considerably overgrowth of the <111> at the expense of the <100>, resulting in a homogeneous and thermally stable microstructure. This property is very desirable especially for conductor wires which are subjected to higher operating temperature.

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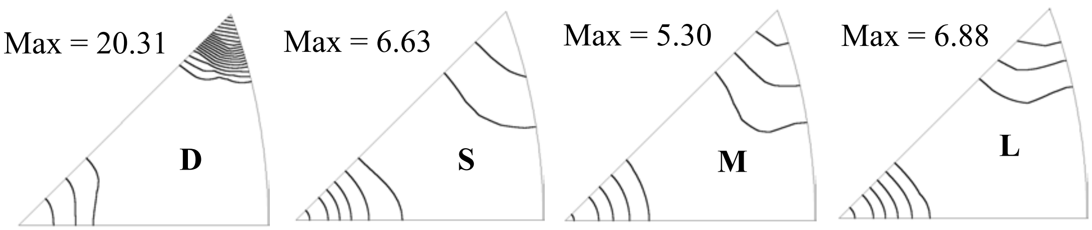

Figure 1 OIM's IPFs showing microtexture of the as-drawn sample (*D*), and samples homogenized at 400°C for 1hr (*S*), 5 hr. (*M*), and 15 hr. (*L*). Contours at 1, 2, 3, ... times random.

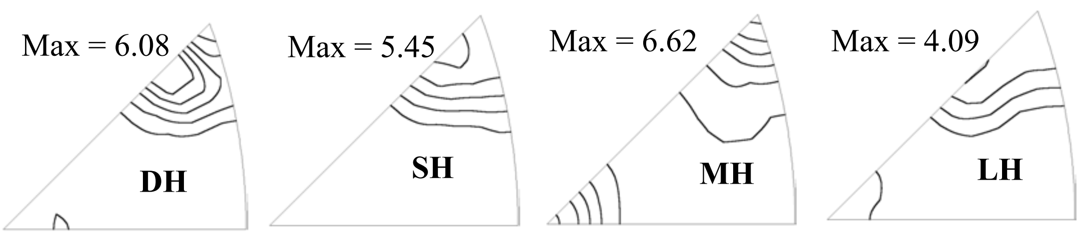

Figure 2 OIM's IPFs, showing microtexture of samples *DH*, *SH*, *MH*, and *LH* after annealing at 750°C for 1 hr. Contours at 1, 2, 3, ... times random.

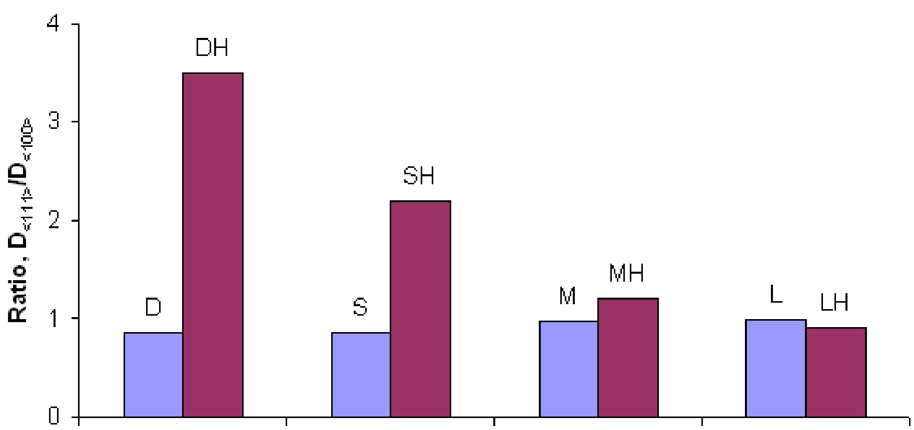

Figure 3 Ratio of the grain sizes of the <111> to <100> in as-drawn sample (*D*), homogenized samples (*S*, *M*, and *L*), and after annealing at 750°C for 1 hr (*DH*, *SH*, *MH*, and *LH*).

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