Microstructure response of cryogenically-rolled Cu-30Zn brass to electric-current pulsing

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Large deformation at cryogenic temperatures is sometimes considered as a promising and cost-effective method for the production of bulk fine-grain materials. The low deformation temperatures are believed to supress dynamic recovery and stimulate mechanical twinning, thereby enhancing grain-refinement. Such an approach may reduce the level of strain required to achieve an ultrafine microstructure and thus the use of industrial working processes to produce ultrafine-grain materials.

For Cu-30Zn brass, cryogenic rolling coupled with subsequent recrystallization annealing was previously shown to be a simple and effective approach for producing an ultrafine microstructure [1]. As an extension of the previous research, the present effort was undertaken to determine the specific

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effect of electric-current pulses (ECP) of very short duration on the microstructure developed in this material.

The program material was manufactured by ingot casting. The material was rolled to a 90% thickness reduction at liquid-nitrogen temperature and then pulsed at an integral current density K_j ranging from 1.29 x 10^4 A^2smm^{-4} to 2.58 x 10^4 A^2smm^{-4}. Grain structure and texture changes were quantified using an electron backscattered diffraction (EBSD) technique.

The pulsing was shown to lead to recrystallization followed by grain growth. The mean grain size in the recrystallized material was 0.5 mkm, thus indicating that cryogenic rolling coupled with ECP is suitable for the production of an ultrafine-grain microstructure in Cu-30Zn brass. However, the processing window is relatively narrow, i.e., from K_j = 1.34 x 10^4 A^2smm^{-4} to K_j=1.42 x 10^4 A^2smm^{-4}. The difference in the recrystallization texture in pulsed versus statically-annealed conditions suggested a distinct recrystallization mechanism during ECP.

References

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