MICROSTRUCTURE AND MICROHARDNESS EVOLUTION OF COMMERCIALLY PURE NICKEL NP1 AFTER CRYOGENIC ROLLING AND ELECTROPULSE TREATMENT

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Abstract: *The present work investigates the influence of cryogenic rolling and subsequent electropulse treatment (EPT) on the microstructure and microhardness of commercially pure nickel NP1. Cryogenic rolling was applied to introduce severe plastic deformation and increase the density of crystal defects. The rolled specimens were subsequently subjected to electropulse treatment with different current densities. Microhardness measurements and Electron Backscatter Diffraction (EBSD) analysis were performed to evaluate structural evolution. The results demonstrated that cryogenic rolling significantly increased microhardness due to strain hardening, while electropulse treatment promoted recovery and recrystallization processes, resulting in a more homogeneous grain structure. The combined processing route provides an efficient method for tailoring the structural and mechanical properties of commercially pure nickel.*

Keywords: *Nickel NP1, Cryogenic rolling, Electropulse treatment, Microstructure, Microhardness, EBSD.*

INTRODUCTION

Commercially pure nickel is widely used because of its high corrosion resistance, ductility, and thermal stability. Modern industrial applications require improved mechanical properties without sacrificing corrosion performance. Grain refinement through severe plastic deformation is considered one of the most effective approaches for strengthening metallic materials. Cryogenic rolling suppresses dynamic recovery, leading to a high density of dislocations and deformation defects. Subsequent electropulse treatment accelerates recovery and recrystallization, allowing rapid modification of the deformed microstructure.

Experimental Procedure

NP1 nickel specimens were cryogenically rolled to a total thickness reduction of approximately 70%. Electropulse treatment was performed using high-density current pulses with a duration of about 100 μs. Microhardness was measured by the Vickers method, and the microstructure was characterized using EBSD.

RESULTS

Cryogenic rolling resulted in a substantial increase in microhardness because of severe plastic deformation and dislocation accumulation. Electropulse treatment reduced internal stresses and promoted recrystallization, producing finer and more homogeneous grains. EBSD analysis confirmed the transformation from elongated deformation grains to equiaxed recrystallized grains. The combined treatment improved the structural stability of NP1 nickel.

Conclusions

The combined application of cryogenic rolling and electropulse treatment effectively modifies the microstructure of commercially pure NP1 nickel. Electropulse treatment accelerates recovery and recrystallization while preserving refined grains. This processing route provides an efficient method for improving the mechanical performance of nickel without conventional long-term heat treatment.

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