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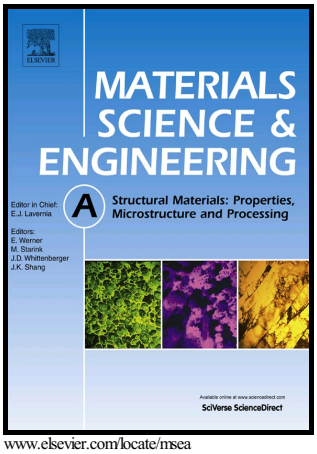

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Hydrostatic cyclic expansion extrusion (HCEE) as a novel severe plastic deformation process for producing long nanostructured metals

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Abstract

In this paper, hydrostatic cyclic expansion extrusion (HCEE) is developed as a new severe plastic deformation technique for processing of the relatively longer ultrafine grained samples. Increasing the length of the processed sample, decreasing the processing load astonishingly, and increasing the hydrostatic stresses are the main advantages of HCEE. In this process, pressurized hydraulic fluid surrounded workplace played the primary role in reducing the friction load and in reducing consequently total load. The HCEE process was applied to commercial pure aluminum 1050 samples at room temperature, and then microstructural evolution and mechanical properties were examined. Microstructure analysis using back-scatter diffraction (EBSD) revealed that a significant grain refinement is achieved after the HCEE process. The average size of grains and subgrains decreased to ~700 nm after two passes of the HCEE process from the initial value of 50 μm in the unprocessed sample. Yield and ultimate strength were increased from 40 MPa and 52 MPa to 125 MPa and 137 MPa after two passes of HCEE process. Also, microhardness was increased from 36 HV to 45 HV after the first pass. The process seems to be very promising for industrial application of SPD processing which suffer from the main challenge of limited sample size.

Keywords: Severe plastic deformation, Hydrostatic Cyclic Expansion-Extrusion, Scale-up, electron backscatter diffraction (EBSD), Grain refinement.

1. Introduction