Characterization of ultrafine-grained aluminum tubes processed by Tube Cyclic Extrusion–Compression (TCEC)

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Abstract

Tube Cyclic Extrusion–Compression as a novel severe plastic deformation technique for tubes was utilized for processing ultrafine grained 1050 aluminum alloy for the first time. In this method, aluminum tube is fully constrained and deformed between mandrel and chamber with a small neck zone. The material deformation during Tube Cyclic Extrusion–Compression processing analyzed and the grain refinement mechanism were described. The capability of Tube Cyclic Extrusion–Compression in grain refinement of the aluminum alloy was demonstrated by transmission electron microscopy observations and X-ray diffraction line profile analysis. The micrographs of the evolved microstructure show grain size of 850 nm and 550 nm after the first and second processing cycles of Tube Cyclic Extrusion–Compression, respectively. Mechanical properties of the initial and processed specimens were extracted from ring-hoop tensile tests. The documented results confirm grain refinement by showing remarkable increase in the yield and ultimate strengths. The main increase in strength and decrease in elongation take place after the first cycle. The microhardness assessments illustrate increase from the initial value of 29 Hv to 44 and 49 Hv respectively after the first and second cycles of Tube Cyclic Extrusion–Compression. There is a good homogeneity in peripheral microhardness and microhardness across the tube thickness.

Graphical Abstract

Highlights

- Tubes of AA1050 for the first time were successfully SPD processed by TCEC.
- The grain size was refined to 550 nm after two cycles of TCEC.
- Notable increase in the strength and decrease in the elongation were documented.
- The microhardness increased to 49 Hv from the initial value of 29 Hv.
- Good homogeneity in the microhardness distribution was recorded.

Keywords

Tube Cyclic Extrusion–Compression; Severe plastic deformation; Ultrafine grained; Microhardness;
Characterization of ultrafine-grained aluminum tubes processed by Tubular pure copper grain refining by tubular cyclic extrusion-compression (TCEC)
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