A large-scale heterostructured Cu-Ni-Cr-Si alloy produced by radial shear rolling

Jairo Alberto Muñoz[1, *], Pere Barriobero-Villa[1], José María Cabrera[1, 2]

[1]Department of Materials Science and Engineering EEBE, Universidad Politécnica de Catalunya, c/Eduard Maristany 10-14, 08019 Barcelona, Spain.
[2]Fundació CIM-UPC, c/Llorens i Artigas 12, 08028 – Barcelona, Spain.

* Corresponding author: jairo.alberto.munoz@upc.edu

Abstract

Functional metallic materials require a good balance of properties like strength and ductility. In this context, heterostructured metallic materials emerge as a highly effective choice to meet these criteria. In this study, the Cu-Ni-Cr-Si alloy was subjected to thermomechanical processing utilizing the radial shear rolling (RSR) process to produce 20-mm-diameter rods with microstructural gradients along the radial direction. The RSR process results in a deformation mode that induces more shearing at the edge of the rod compared to the center. This leads to a greater grain refinement toward the edge of the sample, suggesting the development of a gradient-type microstructure. The RSR deformation gradient resulted in a greater degree of randomness in the texture of the zones located in close proximity to the surface, resulting in a more prominent amount of subgrains and grain fragmentation. The use of solubilization and aging treatments following RSR processing led to the formation of recrystallization texture components and a faster rate of grain growth around the periphery of the rod, which gradually decreases with increasing distance from the rod edge. By conducting synchrotron measurements, dislocation gradients were observed in the RSR and RSR plus heat treatment conditions. These gradients went from high to low densities from the edge to the center in the RSR condition, and from low to high densities in the RSR plus heat treatment condition. The RSR processing proved to be effective in generating heterogeneous microstructures in the copper alloy, leading to a beneficial combination of high strength and ductility. The alloy achieved a yield strength of 600 MPa and a uniform elongation of 15%.