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Marko Knezevic, Abhishek Bhattacharyya

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Characterization of microstructure in Nb rods processed by rolling: Effect of grooved rolling die geometry on texture uniformity

Marko Knezevic[a, *] and Abhishek Bhattacharyya[b]

[a] Department of Mechanical Engineering, University of New Hampshire, Durham, NH 03824, USA
[b] H.C. Starck, Newton, MA 02465, USA

Abstract

Uniformity of crystallographic texture in rods of niobium (Nb) is one of the most important microstructural parameter determining the quality of rods. In this work, we perform a quantitative texture uniformity study in rods of high purity Nb, which were manufactured by rolling using square-to-round shaped rolling die assembly and oval-to-round shaped rolling die assembly. After rolling, the rods were annealed under the same condition. Texture characterization was carried out using electron backscatter diffraction (EBSD). We observe that the oval-to-round die assembly produced a more uniform <110> fiber texture in the rod cross-section compared to the square-to-round die assembly. To confirm the observation, texture in the rods processed in the two different dies were quantitatively compared through the calculations of two suitably defined metrics: texture difference index (TDI) and pole figure difference (PFD). The calculations verify that rolling of Nb in the oval-to-round shaped die assembly produces rods of superior texture uniformity. Strain fields developed in the rods during the two processes were predicted using finite element (FE) analysis. The strain distribution in the rod made using the oval-to-round shaped dies was determined to be more uniform than in the rod made using the square-to-round shaped dies. In particular, the simulations reveal that the square-to-round rolling dies create highly localized strains that are detrimental towards achieving uniform final microstructure in the rods.

Keywords: Niobium; Rods; Rolling; Texture; Texture difference index, Pole figure difference

[*] Corresponding author at: University of New Hampshire, Department of Mechanical Engineering, 33 Academic Way, Kingsbury Hall, W119, Durham, New Hampshire 03824, United States. Tel.: 603 862 5179; fax: 603 862 1865.
E-*mail address*: marko.knezevic@unh.edu (M. Knezevic).