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Microstructural and texture evolution of Jethete M152 flanged-test pieces during cold rotary forging

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ABSTRACT

Rotary forging is an attractive incremental metal forming with many advantages over any other processes, requiring smaller deformation force and providing high accuracy (near-net-process). The main applications of rotary forging process include families of bevel and helical gears, and flanged components for transmissions such as disk, rollers, wheels, etc. The main aim of this work is to study the impact of rotary forging process on the microstructural and texture evolution of high-strength materials, and martensitic stainless steels in particular, during cold rotary forging process. Jethete M152 alloy is a cold formable 13%-Cr martensitic stainless steel used in the aerospace industry. Jethete M152 flanged test-pieces were rotary forged at room temperature. The process was interrupted at 4 intermediate steps, providing flange reductions of 25, 30, 50, 65 and 70 %. A complex grain flow and inhomogeneous deformation patterns are developed during rotary forging, characterized mainly by the formation of a strong deformation band which run parallel to the bottom die. A transition from asymmetrical bulging (inverted mushroom) to symmetrical bulging was observed as a result of the initial lower contact area of the preform with the bottom die. From microstructural analysis by EBSD, the lath structure of Jethete M152 is gradually reoriented and changes it shape in a direction parallel to the compression plane, developing a lamellar/pancake structure in those positions with maximum deformation. These microstructural changes are accompanied with the development of a strong texture formed by a duplex <100> + <111> fibers aligned with the compression axis, being the <111> fiber the stronger one. These findings are in good agreement with uniaxial compression for bcc metals. The analysis of the Orientation Distribution Figures (ODF) reveals that 4 main texture components are formed in the course of the rotary forging process: *Brass* {110}⟨112⟩, *L* {110}⟨110⟩, *I* {112}⟨110⟩, and *Cube* {001}⟨100⟩. In contrast with reported literature for bcc metals, no texture component associated to the γ-fiber ({111} || ND) was found.