CRYSTALLOGRAPHIC TEXTURE EVOLUTION IN THE CRYOGENIC TEMPERATURE-FRICTION STIR PROCESSED AA6XXX ALLOY: EXPERIMENTS AND SIMULATIONS

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Abstract

In this study, we investigated the crystallographic texture evolution in AA6xxx sheet alloy that underwent friction stir processing (FSP) at room temperature (RT) and at cryogenic temperature (CT). AA6xxx sheet samples were subjected to FSP with tool rotation speeds of 600 to 1200 RPM and a feed rate of 500 mm/min. Microstructural and microtexture characterizations were conducted using electron backscatter diffraction (EBSD), scanning electron microscopy (SEM), and high-resolution transmission electron microscopy (HR-TEM) techniques. A coarse grain with shear-type texture was observed in the initial (as-received) sheet sample. After CT-FSP, a homogeneous distribution of grains was noted in the stir zone (SZ), the thermomechanically affected zone (TMAZ), and the intermediate regions between the TMAZ and the base metal (BM). Conversely, heterogeneous grain size distribution was observed in the RT-FSP sample. The surface region near the SZ exhibited a strong Rotated Cube (RCube) component, which decreased in intensity towards the TMAZ and adjacent areas. The retreating side (RS) and advancing side (AS) also displayed differences in texture evolution. In CT-FSP, Cube and Goss components were dominant on the RS and AS, respectively. DEFORM™ software was utilized to simulate the FSP deformation history and to examine the effect of temperature on the evolution of precipitates. Furthermore, texture prediction during the FSP process, which features dynamic recrystallization (DRX) in different regions, was analyzed with the assistance of visco-plastic self-consistent (VPSC) simulations. Precipitate behavior and distribution were analyzed using an advanced image processing technique through an in-house developed MATLAB™ code. The effects of precipitate dissolution on the evolved texture in RT- and CT-FSP samples were also simulated.

Keywords: Al alloys, CT, FSP, Crystallographic Texture, Precipitates, DSRX, VPSC

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