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MICROSTRUCTRE ANALYSIS IN COPPER ALLOY BY FRICTION STIR ADDETIVE MANUFACTURING

Majid Elyasi[1*], Davood Khoram[2], Hamed Aghajani[3], Mohamad Javad Mirnia[4]
[1] Department of Mechanical Engineering, Babol Noshirvani University of Technology, Babol, Iran
[2] Department of Mechanical Engineering, Babol Noshirvani University of Technology, Babol, Iran
[3] Department of Applied Mechanics, University of Deusto, Deusto, Spain
[4]Department of Mechanical Engineering, Babol Noshirvani University of Technology, Babol, Iran
*elyasi@nit.ac.ir

ABSTRACT

Friction additive manufacturing technology (FAM) is a subdivision of additive manufacturing technology. Because of its solid-state characteristics, deposition by FAM shows better mechanical performance than other technologies such as powder bed fusion technologies. This paper presents a development on FAM of a multi-layer copper workpiece. The copper plate was placed on top of other plates and clamped, a stirring tool with a pin was inserted into the plate at a high rotation speed. The friction between the tool and the workpiece produced heat to soften the surrounding material. As the stirring tool moves, the material along the path continues to plasticize, and a firm bond is formed after cooling. This process continued with more plates added until the required height was achieved.

In the FAM process, the thermal cycle during each additive process has an impact on the microstructure of the accumulated materials. Therefore, the microstructure in each layer is different in the FAM process. So, in this paper, the effect of process FAM parameters on the connection of copper sheets layers has been investigated. For this purpose, seven layers of copper sheets were joined layer by layer. The sheets were selected from C11000 copper. This grade of copper has excellent electrical and thermal conductivity, good strength, and ductility. Defects and the effective parameters on the defects in the process were examined. The microstructure of the connection of the layers is also investigated in this paper.

The obtained results illustrate that inhomogeneous microstructures were found in the stir zone, and the dominant feature of the macrostructure is the repetition of the overlapping zones between two adjacent layers obtained a nearly complete cross-section. In addition, it was found that the color of the upper layer was obviously darker than that of the lower layer, and observed defects such as kissing bond at the bonding interface. In terms of grain distribution, due to the state of high shear and high-temperature process, the grain has a strong refinement. Also, it was observed that the microstructure of different layers with optical microscopy. By comparison, it was found that the microstructure in the substrate was coarser banded along the direction of rolling. As a result of plastic deformation and the thermal cycle in the additive process, dissolution, coarsening, dynamic recrystallization, and other phenomena occurred.

Keywords: FAM, Copper, Microstructure analysis, Process parameters