**Abstract**

Aim of this research is first to evaluate the applicability of micro-friction stir welding (μFSW) to wrought zinc alloy sheets and then to improve the structural integrity of such joints. μFSW tool design was based on an algorithm that considers material and process limitations. Joining trials were performed at different feed rates. It is proven that joining by μFSW thin ZnTiCu sheets is possible and it offers extremely fine microstructures and β-phase distribution due to the mechanical fragmentation which is the outcome of the stirring. The β-phase particles were homogenized and precipitated inside deformed zinc grains and not at the grain boundaries, where they used to be in fusion welds. Electron microscopy showed that its size was limited to 150 nm, which is in average 13 times smaller than the size of the 2 μm that they get when sheets are TIG welded. Macroscopically, the μFSW joint mechanical properties are comparable with industrially fusion-welded material. The relative low elongation achieved, similar to fusion-welded sheets, is explained by the occurrence of three main defects: root opening, thinning and kissing bond.