
Investigating the Influence of Temperature and Strain on the Deformation and Cracking Behavior of Y-added Zn-1Al-2.5Mg Extruded Wires

Khushahal Thool*¹, Wi-Geol Seo¹, and Shi-Hoon Choi¹

¹Sunchon National University – South Korea

Abstract

Pseudo-alloy coatings, formed through the thermal spray method, present an economical solution for corrosion protection in large-scale industrial applications such as welding. These coatings exhibit a broad range of properties; however, obtaining precise control remains challenging due to wires with different compositions. In contrast, using a single wire with a predetermined composition promises better control over the deposited coating's composition, microstructure, and thickness, enabling application-specific modifications. In this regard, Zn-Al-Mg coatings, which have received increasing attention due to their enhanced corrosion resistance, pose as an ideal wire material. However, the intrinsic brittleness of Zn-Al-Mg alloy underscores the need for a comprehensive understanding and optimization of deformation behavior during extrusion, a pivotal stage in wire production. This work thus highlights and elucidates the deformation and cracking behavior of Yttrium (Y) added Zn-1Al-2.5Mg-xY alloy as a function of deformation temperature and plastic strain. Controlled Y additions at concentrations of 0.2, 0.6, and 1 percent were introduced to the Zn-Al-Mg alloy and successfully extruded to 1.8 mm wires with a newly developed multi-hole extrusion strategy. Wire deformation behavior was examined through a purpose-built miniature tensile testing setup, incorporating a temperature-controlled heating setup reaching up to 250°C. Small-scale tensile samples, prepared with custom-designed jigs fabricated through additive manufacturing, were subjected to ex-situ interrupted tensile tests across varied temperatures, including ambient conditions and plastic strains. Electron Backscatter Diffraction (EBSD) and surface roughness data, acquired at different strain levels and temperatures, were systematically analyzed to understand crack initiation in the extruded samples. A refined microstructure with increasing Y content post-extrusion led to enhanced mechanical properties, while grain texture appeared to be similar. With increased Y content, the intermetallic band size was reduced during extrusion. The improvement in mechanical properties of extruded wires was correlated to the grain refining and recrystallization retardation effect of Y addition.

Keywords: ZnAlMgY wire, Multiphase deformation, Microstructure evolution, Deformation temperature, Tensile testing, EBSD, Cracking behavior

*Speaker