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DEPARTMENT OF MECHANICAL ENGINEERING

TITLE OF THESIS:	INDUSTRIAL PROCESSING OF AN Al-Zn-Mg-Cu POWDER METALLURGY ALLOY
TIME/DATE:	11:00am, Thursday, September 14, 2017
PLACE:	Room 3107, Mona Campbell Building, 1459 LeMarchant Street, Halifax Nova Scotia

EXAMINING COMMITTEE:

Dr. Diana Lados, Department of Mechanical Engineering, Worcester Polytechnic Institute (External Examiner)

Dr. Zoheir Farhat, Department of Mechanical Engineering, Dalhousie University (Reader)

Mr. Ian Donaldson, Advanced Engineering Applications, GKN Sinter Metals (Reader)

Dr. Paul Bishop, Department of Mechanical Engineering, Dalhousie University (Supervisor)

DEPARTMENTAL REPRESENTATIVE:	Dr. Dominic Groulx, Department of Mechanical Engineering, Dalhousie University
CHAIR:	Dr. Richard Nowakowski, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

The industrial processing of a commercial 7xxx series aluminum powder metallurgy alloy was studied in this work. Key aspects considered included direct comparisons of laboratory and industrially processed specimens as well as the implementation of post-sinter operations in an effort to increase the mechanical properties of the material. These included sizing, heat-treatment, and shot peening.

Industrial pucks experienced appreciable losses of Zn via evaporation in sintering. Ultimately, the Zn concentration dropped to 3.1 wt% near surface, before increasing and stabilizing at the bulk composition of 5.6 wt% approximately 3 mm deep into the product. Nominal values for the sintered density (2.74 g/cm^3), Young's modulus (65 GPa), yield strength (459 MPa), ultimate tensile strength (465 MPa) and elongation to fracture (1.0%) were all in-line with previously published results for laboratory processed specimens, attesting to the scalability of the alloy for industrial applications. Peening to an intensity of 0.4 mmN induced a maximum compressive residual stress near-surface of 230 MPa, extending to a depth of 60-100 µm prior to transitioning to tensile stresses.

Sizing was incorporated within the post-sinter processing sequence to better represent industrial production of geometrically complex parts from the alloy. In certain instances, sizing was applied directly after sintering and prior to the solutionization and aging stages of T6 heat-treatment. In others, sizing was applied as an intermediate step within heat treatment operations, after solutionizing but prior to artificial aging. Application of the former yielded a product with a hardness of 85 HRB and fatigue strength of 228 MPa. As both values were well aligned with the properties of unsized T6 samples, it was concluded that sizing had a neutral impact on these particular attributes when applied in this manner. Interestingly, when sized in the solutionized state, the apparent hardness (78 HRB) and fatigue strength (168 MPa) were reduced to a statistically significant extent. These declines were ascribed to the partial annihilation of quenched-in vacancies that subsequently altered the nature of precipitates within the finished product as supported by DSC and TEM findings. The alloy responded well to shot peening, as fatigue strength was increased to 294 MPa.