Microstructure and Properties of Hot Compacted Powder of Aluminium Alloys

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Atomized 6061 aluminum alloy powders also addition of 2 wt. % of Zr were milled 80 hours in planetary ball mill and then were pressed in vacuum under pressure of 600 MPa at 380 °C. The samples of compacted powders contained small amount of pores and cracks. The microhardness of milled powders was about 170 HV and after hot pressing increased up to 260 HV and for powders with Zr additions to 280 HV. Compression tests have shown high yield stress (YS) approaching 210 MPa and ultimate compression strength (UCS) 300 MPa for hot pressed samples from initial powders. Mechanical properties increased significantly for ball milled and hot pressed samples up to YS - 650 MPa and UCS - 700 MPa. Slightly higher values have been obtained for samples with Zr addition.

The effect hot pressing on the structure of powders have been investigated using transmission electron microscopy (TEM) and high-angle annular dark field scanning transmission electron microscopy (HAADF-STEM) combined with EDX microanalysis. Hot pressed samples from initial powders have shown a cellular structure with particles of the Mg_2Si, AlFeSiMg and Si-rich phases located in the intercell areas. The homogenous structure of small grains with sizes near 100 nm was observed in the samples from the powders ball milled before compaction. The particles of other phases breaking up during milling were uniform distributed in both samples. The Si enriched particles with the sizes up to 100 nm coexist with smaller AlFiSiMg particles identified as metastable tetragonal phase (a=0.495nm, c=0.707nm) and fine Mg_2Si particles of sizes below 10 nm. The presence and location of these fine particles are attributed to the pining of grain boundaries during hot pressing process. In the alloy with zirconium addition Zr-rich particles containing up to 80 at% of Zr were identified as a metastable face center cubic phase with lattice constant = 0.48 nm, similarly as in the ball milled powder.