Name: **Mohammad Mohsin**

Supervisors:

Prof. Aas Mohd. (Supervisor)

Jamia Millia Islamia, New Delhi

Dr. M. Arif Siddiqui (Co-Supervisor I)

AMU, Aligarh

Prof. Mohd. Suhaib (Co-Supervisor II)

Jamia Millia Islamia, New Delhi

Topic: **Effect of Compaction Pressure on Green and Sintered Properties of Synthesised Aluminium Powder Composites**

Department: **Mechanical Engineering**

ABSTRACT

The present research work has been carried out with the aim of fabricating and testing an aluminum alloy matrix composite reinforced with alumina (Al_2O_3) through powder metallurgy technique / route. Powders of aluminium (Al), iron (Fe), chromium (Cr) having mean diameter 48, 150 and 100 µm respectively were used. Moreover alumina (Al_2O_3) particles were 100 µm mean diameter. The Aluminium matrix (Al, Fe, and Cr) powders were taken in weight percentage of Al-75%, Fe-20%, Cr-5%. In the next stage, this mixture of Al-matrix powder was mixed with Al_2O_3 powder by varying weight percentage of 0–30, to make a final mixture of powders in composition of Al–Fe–Cr-X% Al_2O_3 (X = 0, 10, 20, 30 wt.%). Mixing of powders was carried out in a centrifugal type ball mill (Fritsch Pulverisette MM-1552) keeping ball to powder weight ratio (BPR) 10:1 for 30 minutes. The green cylindrical compacts prepared were sintered in a tubular electric furnace at 450 ^oC for 30 minute under argon atmosphere (flow rate = 1.0 lit. min^{-1}). Effect of different compaction pressures viz. 470, 550 and 600 MPa on green and sintered properties (density, hardness, wear and electrical behaviour) were examined. Moreover, tensile specimens of MPIF standard were also prepared having same compositions under the compaction pressure of 200, 250 and

300 MPa. The green tensile specimens were sintered in a tubular electric furnace at 580-610 ^{o}C for 1 hour under argon atmosphere (flow rate = 1.0 lit. min^{-1}). Scanning electron microscope (SEM), x-ray diffractometer (XRD), energy dispersive microscope (EDS) and elemental mappings were used for characterization of powder and compacts (green and sintered). The wear study of the composites was performed on pin-on-disc apparatus at sliding conditions (applied load 40 N, sliding speed 1.5 m s^{-1}, and sliding distance 300 m). The electrical conductivity test was performed on 4-probe set-up. SEM analysis was also carried out to understand wear mechanism of the worn surfaces of various fabricated composites and aluminium matrix. Uniform distribution of Al_2O_3 in aluminium matrix was observed by elemental mapping.

The results revealed that aluminium composites reinforced with alumina particles exhibit superior density, hardness, tensile strength and wear resistance than aluminium matrix composites. An increase in density and hardness has been found by increasing both alumina and compaction pressure. While, electrical conductivity decreased by the addition of alumina. The wear loss decreased with increasing both alumina and compaction pressure. Tensile strength increased as percentage alumina increases from 0-20% but reduced further at 30 wt. % alumina irrespective of compaction pressure. Percentage elongation reduced as alumina percentage increased for all compaction pressures. Fractographs showed that at less concentration of alumina uniform distribution of reinforcement is achieved which attributes the enhancement of mechanical properties including tensile strength up to 20 wt. %. However further at 30 wt. % of alumina agglomeration persists which is the main reason for reduction in the tensile strength. Analysis of variance (ANOVA) was performed to analyze the effect of various input parameters on the output response of the investigated properties. Two input parameters, reinforcement percentage and compaction pressure with four and three levels respectively were considered for analysis. It was revealed that the most influencing factor affecting the density, hardness, tensile strength, wear loss and electrical conductivities were alumina wt. %, alumina wt. %, compaction pressure, alumina wt. % and alumina wt. % respectively.