CHAPTER-3

SCOPE OF PRESENT WORK

Based on literature survey the need and objectives of investigation and work plan are highlighted in this chapter.

3.1 NEED OF INVESTIGATION

The characterization and machinability studies of aluminium alloy-SiC particle composite has been undertaken keeping in to consideration the following problems envisaged during fabrication, characterization and machining of 7075 aluminium alloy SiC particle composite.

i. Fabrication of porosity free 7075 Al alloy SiC composite.

ii. Microstructural examination.

iii. Improvement of mechanical properties.

iv. It has been long recognized that cutting conditions such as feed rate, cutting speed and depth of cut in machining operation should be selected to optimize the economics of machining operations as assessed by productivity, total manufacturing cost per component or some other suitable criterion.

v. High cost of numerically controlled machine tools, compared to their conventional counter parts, has enforced us to operate these machines as efficiently as possible in order to obtain the required payback.
vi. Machining of 7075 Al alloy SiC composite still is a challenge. Machining is essential to make Al alloy SiC composite suitable for industrial use. The investigation of optimal machining parameters is thus very essential.

vii. The recently developed tool materials like multi layer coated carbide, cubic boron nitride and poly crystalline diamond may be suitable for difficult to machine materials. In this work, TiN coated tungsten carbide inserts (CNMG 120404, CNMG 120408 and CNMG 120412) have been used for machining of Al alloy SiC composite to assess the performance.

3.2 OBJECTIVES OF PRESENT INVESTIGATION

The present research work has been undertaken with a main objective to overcome the problems during fabrication, characterization and machining of AA7075/SiC composites. The work is focused on the following aspects:

i. Fabrication of 7075 Al alloy with 10wt%, and 15wt% of SiC particulate (Particle size 10 - 20 µm and 20 - 40 µm) composites with minimum porosity.

ii. Microstructural examination by optical microscope and scanning electron microscope to study the proper distribution of grains.

iii. Characterization of 7075 Al alloy, AA7075/10wt%SiCp (10- 20µm), AA7075/15 wt %SiCp (10- 20µm), AA7075/10wt%SiCp (20- 40µm), and AA7075/15wt% SiCp (20- 40µm) composites by EDAX, EPMA, DTA, XRD and TMA.

iv. Carry out tests to find out mechanical properties like Young’s Modulus, tensile strength, compressive strength and hardness.
v. CNC Turning machine performance evaluation using Design of experiments.  
(Response Surface Methodology)

a. Analyzing the effect of machining/process parameters (cutting speed, feed, depth of cut, and nose radius of tool) on surface roughness, tangential force, feed force, radial force, power consumption, flank wear and crater wear.

b. Understanding the behavior of carbide insert in machining of 7075 Al alloy and AA7075/SiCp composites.

c. Analyzing the effects of different cutting conditions on tool-life and tool wear.

vi. Single objective optimization of machining/process parameters by desirability function to minimize surface roughness, tangential force, feed force, radial force, power consumption, flank wear and crater wear and to maximize tool-life.

vii. Multi objective optimization by desirability function to minimize surface roughness, tangential force, feed force, radial force, power consumption, flank wear and crater wear and to maximize tool-life.

viii. Experimental validation of results.

ix. Optimization of process parameters by using genetic algorithm tool box.

x. Comparison of optimization results obtained by desirability analysis and genetic algorithm.

Factors affecting the fabrication process and responses affecting the mechanical properties have been identified and are shown in figure 3.1. Factors affecting the machining process and responses are indicated in figure 3.2.
Figure 3.1: Ishikawa – Cause and Effect Diagram for Characterization

Figure 3.2: Ishikawa- Cause and Effect Diagram for Machining
3.3 WORK PLAN

To accomplish the objectives, the present work has been planned in eight phases.

Phase-I

(a) Fabrication of 7075 Al alloy and composites with 10, 15 wt % SiC particulates of size 10-20 µm by stir casting process at different stirring speed and stirring time.

(b) Fabrication of 7075 Al alloy and composites with 10, 15 wt % SiC particulates of size 20-40 µm by stir casting process at different stirring speed and stirring time.

Phase-II

(a) Preparation of specimens of 7075 Al alloy, 7075Al/10wt%SiCp and 7075Al/15wt%SiCp (particle size 10 - 20 µm and 20-40 µm) composite for microscopic examination.

(b) Study of microstructure of 7075 Al alloy, 7075Al/10wt%SiCp and 7075Al/15wt%SiCp (particle size 10 - 20 µm and 20-40 µm) composite.

Phase-III

Energy Dispersive X-ray Analyses (EDAX), Electron Probe Microscopic Analysis (EPMA), Differential Thermal Analysis (DTA), X- Ray Diffraction Analysis (XRD), Thermo Mechanical analysis (TMA), of 7075 Al alloy and 7075Al/10wt%SiCp and 7075Al/15wt%SiCp (particle size 10 - 20 µm and 20-40 µm) composites have been carried out.

Phase-IV

Find out the value of Young’s modulus, peak frequency, hardness, tensile strength and compressive strength of 7075 Al alloy, 7075Al/10wt%SiCp and 7075Al/15wt%SiCp
(particle size 10 - 20 µm and 20-40 µm) composite to analyze the improvement in properties of 7075 Al alloy due to addition of SiC particles.

Phase-V

(a) To find out range of process parameters using pilot experiments.

(b) Development of regression model of surface roughness, tangential force, feed force, radial force, power consumption, flank wear, crater wear and tool life using Response Surface Methodology (RSM). Face centered central composite method was used to plan the experiments and input parameters varied are cutting speed, feed, depth of cut and nose radius.

Phase-VI

(a) Development of single objective optimization model using Response Surface Methodology and Desirability function.

(b) Development of multi-characteristic optimization model using Response surface Methodology and Desirability function.

(c) Determination of optimal sets of CNC turning process parameters for desired combined quality characteristics.

(d) Single objective optimization of process parameters by genetic algorithm in MATLAB tool box.

(e) Experimental verification of optimized individual quality characteristics.