Chapter 6

CONCLUSIONS

The conclusions of the research work undertaken are;

- The LM13-ZrO₂ nano metal matrix composite materials have been fabricated by stir casting method followed by extrusion process.

- The nano ZrO₂ particulates are evenly dispersed in the matrix alloy. The micro hardness of LM13-ZrO₂ nano metal matrix composite material is superior than the matrix material. The micro hardness increases by 12.2% by the addition of 2 wt.% of ZrO₂ nano particulates in aluminum (LM13) matrix alloy.

- The inclusion of ZrO₂ nano particulates in LM13 matrix alloy significantly enhanced the ultimate tensile strength and yield strength of the LM13-ZrO₂ nano metal matrix composite materials. The 8 wt.% of ZrO₂ reinforced aluminum (LM13)-ZrO₂ nano composite shows 54.11% increase in the ultimate tensile strength as compared to ultimate tensile strength of LM 13 alloy.

- The ductility of LM13-ZrO₂ nano metal matrix composite material decreases as compared to matrix alloy. The ductility decreases by 32.72% with the inducing of 2 wt. % of ZrO₂ nano particulates in aluminum (LM13) matrix alloy.

- The compression strength increases as the fraction of reinforcement enhances in the matrix material. The 8 wt.% of ZrO₂ reinforced as-cast aluminum (LM13)-ZrO₂ nano composite
shows 40.32% increase in the compression strength as compared to compression strength of aluminum (LM13) alloy.

- Fracture toughness increases as the reinforcement substance amplifies in the matrix material. The fracture toughness increases by 130% by the addition of 2 wt. % of ZrO₂ nano particulates in LM13 matrix alloy.

- The wear resistance increases as the wt. % of reinforcement substance amplifies in the matrix material. The wear resistance of aluminium (LM13) +6 wt.% nano ZrO₂ MMC shows 40.76% increase in the wear resistance as compared to wear resistance of aluminum (LM13) alloy. The wear resistance of 6 hrs heat treated aluminium (LM13) alloy increases by 21.57% and increase 14.28% in the wear resistance of extruded aluminium (LM13) alloy with that of as-cast aluminium (LM13) alloy.

- The wear resistance decreases as the applied load boosts. The wear rate of aluminium (LM13) +6 wt.% nano ZrO₂ MMC increases by 2.99% as load increases to 40N and when load increase to 80N, the wear rate of aluminium (LM13) +6 wt.% nano ZrO₂ MMC increases by 29.68% with that of 20N loaded aluminium (LM13) +6 wt.% nano ZrO₂ MMC.

- The wear rate in both the LM13 / nano ZrO₂ metal matrix composites and the matrix material enhances as the sliding distance increases.

- The wear rate in both the LM13 / nano ZrO₂ metal matrix composites and the matrix material decreases as the sliding velocity enlarges. The wear rate of aluminium (LM13) +6 wt.% nano ZrO₂ MMC decreases by 13.29% as sliding velocity increases to 1.728 m/s.
• The sliding distance increases, the coefficient of friction in both the LM13 / nano ZrO₂ metal matrix composites and the matrix material enhances.

• The coefficient of friction of the matrix material is more than that of the composites for all sliding velocities and as the proportion of reinforcement boosts, the coefficient of friction of the aluminum (LM13)-nano ZrO₂ metal matrix composite decreases.

• The wear resistance is more in LM13 / nano ZrO₂ MMC as compared to the matrix material.

• The SEM photograph of the worn surface of NMMC with 8 Wt. % ZrO₂ was found higher wear resistance in contrast to the worn surface of matrix alloy.

• The thermal conductivity decreases as the reinforcement content increases in the matrix material. The extruded LM13-ZrO₂ nano composite shows decreased thermal conductivity as compared to as cast LM13-ZrO₂ nano composite.

• The 6 hrs heat treated LM13-ZrO₂ nano composite shows decreased thermal conductivity as compared to as cast and extruded LM13-ZrO₂ nano composites.

• The coefficient of thermal expansion of as-cast aluminum (LM13)-nano ZrO₂ metal matrix composites declines as the reinforcement fraction enhances.

• The operating temperature enlarges the coefficient of thermal expansion of aluminium (LM13) alloy and aluminum (LM13)-nano ZrO₂ MMCs. The heat treatment and extrusion process decreases the coefficient of thermal expansion of aluminium (LM13) alloy and aluminum (LM13)-nano ZrO₂ MMCs.