CHAPTER 2

OBJECTIVE OF THE WORK

In mechanical engineering, innovative methods with the rigorous research made it possible to implement new designs using advanced material systems for the development of a variety of machinery for new and diversified applications. Metals and their alloys are extensively used for structural and mechanical applications. The development of metal matrix composites with metal/metal alloy as matrix and ceramic as reinforcement is an innovative approach for developing material for better strength, wear & corrosion resistance and high-temperature stability. Powder metallurgy is a simple, reliable and cost-effective route for such metal matrix composites. In recent years Gupta et al. [38, 39] and Jha et al. [89] have extensively worked on Fe-Al_2O_3/ Fe-ZrO_2 Metal Matrix Composites (MMCs) synthesized by powder metallurgy (P/M) route. They reported the effect of reinforcement content and processing parameters, i.e., sintering temperature and time on the mechanical, tribological and corrosion behavior of Fe-Al_2O_3/ Fe-ZrO_2 Metal Matrix Composites. Nickel is used as an alloying metal for developing corrosion-resistant alloys and intermetallic compounds. In the making of different grade stainless steels, 6-22% of Ni is used for improving strength, toughness, ductility and also the corrosion resistance at active sites.

Therefore, in the present thesis, the aim was to initially synthesize iron-nickel alloys (10-50 wt% Ni) using powder metallurgy and chemical synthesis route. The optimized alloy

composition was used as a matrix for fabricating particulate reinforced metal matrix composites. There is a lack of systematic studies on mechanical and corrosion behavior of ZrO_2 reinforced Fe-Ni alloy based metal matrix composites to the best of our knowledge. The present work is also focused on the investigation on the effect of ZrO_2 particles concentration on the mechanical and electrochemical behavior of $Fe_{(100-x)}Ni_{(x)}$ matrix composites and developing a wear resistant and corrosion resistant composite for heavy duty applications.

The objectives of the present work are as follows:

1. Synthesis of different alloy and composite specimens

- To synthesize $Fe_{(100-x)}Ni_{(x)}$ alloys by varying Ni content from 10 to 50 wt.% at an interval of 10 wt.% using powder metallurgy route with sintering in the temperature range from 1000-1250°C for 1h in argon atmosphere.

- Optimization of the alloy composition of $Fe_{(100-x)}Ni_{(x)}$ to be used as matrix for composite synthesis by measuring and comparing the mechanical and corrosion behavior of various alloys compositions.

- To synthesize ($Fe_{70}Ni_{30}$)-ZrO_2 composites with varying ZrO_2 particles content (0, 2.5, 5, 10 and 15 wt.%) using powder metallurgy route and sintering at 1150°C for 3h in inert atmosphere.

- To use sol-gel auto-combustion method followed by reduction in hydrogen atmosphere to synthesize $Fe_{(100-x)}Ni_{(x)}$ alloy nanopowders with varying Ni content 10, 30 and 50 mole%.

- To synthesize ($Fe_{70}Ni_{30}$)-ZrO_2 composites with the addition of commercially available nanopowder (0, 2.5, 5, 10and 15 wt.%) and chemically synthesized alloy nano powder via powder metallurgy route with sintering at 900°C for 1h in inert atmosphere.

2. Physical and structural characterization

- To determine the density of the sintered alloy and composite specimens and to study their densification behavior.
- To identify the phase formation in different specimens using X-Ray Diffraction and investigate the effect of composition and processing parameters on the development of phases during sintering.
- To determine the microstructure of as prepared, worn surface and corroded surfaces using Scanning Electron Microscope and study the effect of composition and processing parameters on the development of microstructure of the composites along with the effect of wear and corrosion.

3. Mechanical and Electrochemical characterization

- To study the effect of composition and processing parameters on the mechanical characteristics of the composites.

  a). To measure the hardness of specimens using Vickers Hardness tester.

  b). To measure the wear rate at different loads to study the wear mechanism.

- To study the Electrochemical behavior of specimens in 3.5% NaCl aqueous solution (simulated sea water).