CHAPTER 3

SCOPE OF PRESENT RESEARCH

High hardness, high wear resistance and good chemical stability of the boride layers resulting in the increased service life of steel components, have long attracted the attention of research metallurgists and manufacturers.

During thermo-chemical boriding of plain carbon steels, very high brittleness is generated in the boride layer as well as in the core. High brittleness is reported due to the presence of two phase (Fe$_2$B-FeB) microstructure especially due to hard and brittle FeB phase (formed due to high boron potential), lateral cracks at FeB/Fe$_2$B interface, non-uniform distribution of alloying elements in the boride layer and longtime exposure (1 to 12 h) of the steel at elevated temperature (above 950 °C) resulting in grain coarsening at the core. Because of this brittleness problem, wide-scale industrial acceptance of borided steels has been limited even though it has a very high surface hardness in the range of 1400- 2100 HV.

The task of minimising the brittleness of the boride layers without much compromising the surface hardness or other surface properties such as wear and corrosion resistance is a challenging one.

The focus of the present research is to develop a boride layer on AISI 1020 steel to get adequate hardness (1300 – 1500 HV) and improved toughness (combination of strength and ductility) of the boride layer without much disturbing the bulk properties of the steel. Hence, multicomponent laser
boriding (Ni + Cr + B$_4$C) has been attempted. First a layer of nickel (Ni) and then another layer of chromium (Cr) were electroplated on the surface of steel. Then a paste of boron carbide (B$_4$C) was applied and subsequently laser treated at different energy densities.

The objectives of the present research work are as follows:

1. To develop a multicomponent boride layer on AISI 1020 steel at various energy densities of laser beam.

2. To study and compare the microstructures of continuously pack borided, interrupted pack borided and multicomponent laser borided specimens using optical microscopy and scanning electron microscopy (SEM).

3. To measure and compare the boride layer thicknesses of continuously pack borided, interrupted pack borided and multicomponent laser borided specimens using optical microscopy.

4. To quantify the weight % of boron, nickel, chromium, iron and carbon present in the multicomponent laser borided layer as well as in the transition zone (the zone beneath the boride layer) using energy dispersive spectroscopy (EDS).

5. To identify the phases present in the multicomponent laser borided specimens using X-ray diffraction (XRD) technique.

6. To compare the phases formed with continuously pack borided and interrupted pack borided specimens.

7. To study the microhardness variation along the depth of multicomponent laser borided specimens using Vickers microhardness tester.
8. To compare the microhardness variations along the depth with continuously pack borided and interrupted pack borided specimens.

9. To analyse and compare the fractured surfaces in the charpy impact test of AISI 1020 steel, continuously pack borided, interrupted pack borided and multicomponent laser borided specimens using macrophotography and scanning electron microscopy (SEM).

10. To study and compare the fracture toughness ($K_c$) of continuously pack borided, interrupted pack borided and multicomponent laser borided specimens using Vickers micro indentation fracture toughness test (VMIF).

11. To estimate and compare the wear loss and co-efficient of friction of AISI 1020 steel, continuously pack borided, interrupted pack borided and multicomponent laser borided specimens against continuously pack borided austenitic stainless steel disc using pin-on-disc universal tribometer.

12. To study and compare the corrosion rates of AISI 1020 steel, continuously pack borided, interrupted pack borided and multicomponent laser borided specimens against 2.6 grams of cupric chloride dihydrate ($\text{CuCl}_2.2\text{H}_2\text{O}$) in 1 litre of glacial acetic acid ($\text{CH}_3\text{COOH}$) using potentiodynamic polarization technique.
Figure 3.1 Scope of the Investigation