CHAPTER 1
INTRODUCTION

Both Ferrous and Non Ferrous metals used in various engineering applications are subjected to extreme operating conditions. Service life of components made from these materials can be significantly increased if properties like hardness, wear resistance, corrosion etc are improved at surface level. Sometimes improving a property of the bulk material has detrimental effect on other properties e.g. hardness increase reduces toughness which is not desired in a power transmission shaft. Also bulk property change is costlier than property change within a small depth from the top surface. Various functional properties, like physical, chemical, electrical, electronic, magnetic, mechanical, wear-resistant and corrosion-resistant properties at the surfaces can be modified up to certain depths depending on requirement. The earlier practice of property change throughout the body by alloying or heat treatment has been replaced in many cases with surface modification. Thus surface modification of engineering materials has become a common practice to optimize various property requirements in them in a cost effective method. It can be categorized broadly as:

a) Extra deposition on surface- Deposition can be done by various methods like chemical vapor deposition (submicron level coating), physical vapor deposition, and ion nitriding, laser surface alloying etc. [58,59, 74, 89, and 101].

b) Heat treatment –treatment in vacuum, inert atmosphere cryogenic etc. [25, 31, 51, 52, 58, 62, 84].

c) Treatment by non-conventional energy sources- Plasma, Laser, Electron beams[9,12,13,32,40,44,47,48,64,77,85,89,90,95,96,9101,102].

d) Sputtering- Surface bombardment done with particles having energy several times higher than conventional thermal processes. [34, 56,79].

e) Removal of material from surfaces- Glow discharge treatment and sputter-etching are used for cleaning purposes etc. [55].

Stainless steel is an extensively used engineering material. It is an alloy of chromium in low carbon steel. Sometimes Nickel is also added to it. It has been classified into various grades based on its crystal structures and properties like corrosion, temperature resistant etc. [93].

En-31 is an alloy of hyper eutectoid steel with Chromium. It is also a commonly used engineering material [84].

Extensive work has been done and still being done by various researchers to modify various surface properties of these materials by different methods as already categorized above.

Various theoretical models have been developed by various researchers to predict the temperature of fusion and heat affected zone in welding [2,3,8,15,16,27,37,42,43,57,60,63,65,66,76,77,89,96, 96,97,99]. These can be used to predict heat distribution and cooling pattern in these zones. Heat source shape varied from point source to double ellipsoidal shape. Body dimensions assumed to be finite, semi infinite and infinite.

From the literature review it appears that exploring various methods to modify stainless steel surfaces is a strong contemporary interest of research due to requirement of various special surface characteristics of metallic substrate for advanced industrial application. Each method has its advantages and limitations depending upon, cleanliness, versatility and extent of their influence on the substrate as a function of depth of modification and type of control over the morphology and surface chemistry.
based on thermal characteristics of the system. Various thermal models have been developed to estimate heat distribution and cooling characteristics of the faying surface. In the context of the requirements thermal potentials in this regard the Gas Tungsten Arc power source has already been reported as a useful process especially due to its versatility of its application. But in spite of many unique advantageous knowledge of using pulse current in this process to make it more effective for surface treatment of metallic substrate, its application for this purpose has not been well explored. In view of this an effort has been made in this investigation to study the use of pulsed current Gas Tungsten Arcing (GTA) process on some highly critical metallic substrate of industrial importance as stainless steels and high carbon steel. This unexplored area is addressed to understand the potentials and criticality of application of this process through some experimental and analytical works.

Gas Tungsten Pulsed Arcing is a commonly available method used in industries. It is comparatively cheaper and portable system. Introduction of pulse arcing is a newer development over constant current arcing [84]. Due to application of pulsing; its control is difficult in comparison to constant current arcing system. Use of pulsing introduces various simultaneously interacting parameters like peak current (I_p), base current (I_b), pulse frequency (f), peak current duration (t_p) and base current duration (t_b). Pulse parameters have considerable effect on fusion and heat affected zones. It has also been found that change in one parameter has considerable effect on other due to energy balance concept. A dimensionless parameter has been developed and successfully used in Pulsed Metal Inert Gas Welding and Pulsed Tungsten Inert Gas Welding with use of filler rod [21, 24]. But its usefulness in autogenous (without filler material) mode has not been studied. This particular area can be explored further. So in this work an effort has been made to experimentally modify the surface of stainless and high carbon steel with pulse Tungsten Inert Gas welding technique in autogenous mode at various parameters. The modified surfaces were measured, studied and tested. The various results were discussed to find correlation between them.