CHAPTER III

SCOPE AND OBJECTIVE OF THE PRESENT WORK

In many industrial applications low nickel stainless steel finds a huge appliance as constructive materials for oil pumps, gas pipeline industries and storage tanks etc., due to valid aspects such as, reduced costs (due to its low nickel content) and mechanical strength. But there are also certain failures which may occur due to corrosion when exposed to corrosive environment. So conserving the metal sources and reduction of economic crisis is a major threat to all corrosion experts and thus a numerous efforts are underway to overcome the corrosion problems.

Among those different protective measures against corrosion such as use of inhibitor [211-213], cathodic or anodic protection [214, 215], metal oxide coatings [136, 216, 217] and organic as well as inorganic coatings etc., the coating of low nickel stainless steel substrates using conductive polymers beckons an improved life for the metal [218-224]. Thus the economic inflation may get reduced with the usage of low nickel stainless steel and its protection against corrosion can be achieved by anticorrosive copolymer coatings for industrial purpose.

Inhibitors were widely used in many environments. Even though they are believed to protect the metal, the span of protection for metal may be considerably less. Nearly all powerful inhibitors have detrimental effects that predestine threat to the environment as well as health hazards to the society. This is because, the inhibitors are constantly released into the environment even when they are not needed. Thus the role of inhibitors as anticorrosive agent is less appreciable and thus
there arises a need for a suitable agent that predominantly satisfies all requisites of anticorrosion.

Conductive polymers belong to the class of polymers that owe their electrical conductivity, low cost, fusibility, stability, non-toxic, ease in synthesis [42, 43, 225] and are used for corrosion protection since their discovery [118, 121, 169]. The conductive homopolymers such as polyindole, polypyrrole, polythiophene, polyaniline etc., are widely used either as inhibitors or as coatings for anticorrosive applications. But there are some flaws in those homopolymer coatings including porous nature, delamination in acidic environments and less adhesive performance towards the coated metal specimen, which step up the search of copolymer coatings with the aim of attaining desirable properties. Rather than investing huge capita in maintenance for the use of inhibitors, homopolymers etc., many industrialists as well as corrosion engineers sought to find out a novel way. Thus in order to overcome these undesirable failures most of the studies were recently carried out using electrochemical synthesis of copolymer coatings obtained on metal substrates from varied synthesis parameters that features ease of processability, purity, good conductivity and adhesion to the substrate. Thus the copolymer coatings will provide a redox nature which restricts the external corrosive agents against intrusion through their coatings. They retard the transfer of ions to the interface as well as the electrolyte solution and thus inhibit corrosion for a consistent period of time.

While considering the varied methods of coating such as spray pyrolysis, laser ablation, chemical vapor deposition etc, the electrochemical techniques stands upright with its numerous benefits such as, homogeneity of the coating, desired thickness, cost effectiveness, less time consuming, non-line -of-site i.e., it has an
ability to coat on any complex shapes of substrates. Moreover the electrochemical depositions can be carried out even at low temperatures.

Inspite of the above mentioned advantages, there are still constraints with the usage of copolymer coatings, such as the need of improved adhesive strength and mechanical hardness which are all still questionable. This made us to step forward and work out the bilayer coating to attain all the necessary requirements of an anticorrosive coating in order to fulfill the demands of industrial purposes. There comes the role of ceria coating in the form of bilayer coating on LN SS that provides adhesion strength and mechanical hardness. Thus the present study provides a conceptual idea of using copolymer as well as bilayer coating.

3.2 OBJECTIVES OF THE PRESENT INVESTIGATION

The present investigation is focused on the electrochemical synthesis of poly(In-co-Py), poly(In-co-Th) and CeO₂/poly(In-co-Py) coatings on low nickel stainless steel with the following objectives;

¾ To electrochemically synthesis the copolymer coatings of poly(In-co-Py) and poly(In-co-Th) using different monomer feed ratios and at varied scan rates using cyclic voltammetric technique.

¾ To carry out the cathodic electrodeposition of ceria as a primer coating on LN SS prior to poly(In-co-Py) coating, to improve the protection performance of the copolymer coating on LN SS.

¾ Spectral characterizations of the as-synthesized poly(In-co-Py) and poly(In-co-Th) copolymer coatings to confirm their bonding nature and also purity with the aid of various analytical techniques like FT-IR and ¹H-NMR.
Scope and Objective of the Present Work

¾ To study the phase purity of the as formed cathodically electrodeposited ceria coating on LN SS.
¾ To investigate the morphology of the coatings using techniques like SEM and AFM
¾ To investigate the elemental analysis of the coatings using Energy Dispersive X-ray Analysis (EDAX).
¾ To study the mechanical properties of the coatings using tape testing to determine adherence of the coatings and microhardness test for hardness estimations.
¾ To ascertain the thermal stability of the as-synthesized organic copolymer coatings by TGA and DSC thermograms.
¾ To explore the corrosion protection performance of the copolymer as well as bilayer coatings on LN SS specimens using electrochemical techniques like potentiodynamic polarization and electrochemical impedance spectroscopy.
¾ To carry out the morphological investigations of the coatings along with EDAX for their elucidations on elemental compositions for the coated specimens both before as well as after corrosion studies.
¾ To carry out the leach-out analysis using ICP-AES technique (solution anlysis) to determine the protective efficiency of the coating after polarization measurements.

Based on these objectives, the present investigations on the copolymer and bilayer coatings were framed in order to evaluate their anticorrosive performance in 0.5 M H₂SO₄ investigated.
3.3 WORK PLAN OF THE PRESENT INVESTIGATION

Anticorrosive Performance of Ceria/Copolymer Bilayer Coatings on LN SS in 0.5M H₂SO₄ Medium

Electrochemical Synthesis

Poly(In-co-Py) coating on LN SS (Cyclic Voltammetry)

Poly(In-co-Th) coating on LN SS (Cyclic Voltammetry)

Ceria coating on LN SS (Cathodic electrodeposition)

Bilayer coating (LN SS/CeO₂/Poly(In-co-Py))

Analytical Characterizations of the coatings

Analytical
FT-IR
IH-NMR
Morphological
SEM
AFM
Thermal
TGA
DTA
Electrochemical
Polarization Studies
EIS

Analytical
FT-IR
XRD (CeO₂)
Morphological
SEM
AFM
Thermal
TGA
DTA
Electrochemical
Polarization Studies
EIS

After Electrochemical Studies
Morphological
SEM
Solution analysis
ICPAES analysis