UNIVERSITI TEKNOLOGI MARA

THE DOCTORAL RESEARCH ABSTRACTS

Volume: 8, Issue 8 November 2015

EIGHTH ISSUE

INSTITUTE of GRADUATE STUDIES

IGS Biannual Publication

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Title :
Corrosion Behavior of Nanocrystalline CoNiFe Electrodeposited on Stainless Steel

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The stainless steels are become more susceptible to localized corrosion when they are exposed to harsh environments. This study is to deposit an alternative material focusing on nanocrystalline CoNiFe which has been identified as a potential candidate for replacing hexavalent chromium plating in corrosion resistant coating. This material is recognized as a green material because it does not hazardous to environment. The objectives of this research are to optimize the deposition parameters in synthesise nanocrystalline CoNiFe coating layer on stainless steel and heat treat it to obtain optimum corrosion properties in suitable environments. The CoNiFe coating was synthesised using an electrodepostion process by varying pH solutions (3, 7 & 9) and deposition times (30, 60 & 90 minutes) in order to determine the optimum deposition parameters. Other parameters such as electrolyte composition, temperature and current density were kept constant. The heat treatment process was conducted at the optimum heat treatment temperature of 700°C under two different inert gas atmospheres, which are 100% argon and mixture of 95% argon + 5% hydrogen gases. Lastly, the corrosion behaviour of nanocrystalline CoNiFe with and without heat treatment under various environments was determined. In an optimum electrodeposition parameters (pH 3 and 30 minutes deposition), stainless steel are fully coated by nanocrystalline CoNiFe. Corrosion rate was decreased while hardness was increased due to the fine particles using acidic electrolyte of pH 3. The heat treatment on the coating sample was observed to produce better coating compared to the as-synthesised sample. The heat treated samples with a flowing 100% argon gas revealed the optimum properties with least voids and less agglomerates. Higher hardness and good corrosion resistance was observed with the homogenous microstructure. The optimum corrosion resistance environment of nanocrystalline CoNiFe was alkaline of NaOH and seawater environment. Heat treated nanocrystalline CoNiFe using flowing 100% argon gas is more compatible in alkaline environments compared to mixing gas atmosphere and as-synthesised coated sample. This phenomenon was due to the rearrangement of atoms on the microstructure which produced the smallest particle size and compaction of morphologies. The hardness was seen to increase gradually with the decrement of particle size. It was observed that smaller particle size and homogenous structure was significant in smoothness surface and the slowest corrosion rate. Interestingly, it was found that the corrosion rate for all samples exhibited the slowest corrosion rate compared to the corrosion rate of the stainless steel despite the fact that the sample demonstrates the active corrosion. This study contributes the useful guideline for the corrosion behavior of nanocrystalline CoNiFe with and without heat treatment in different natural and pH environments. This finding could be significant in stainless steel design and manufacturing application especially involved in corrosion environments exposure.