Performing the biomimetic morphing method on a Micro Air Vehicle (MAV) wing is very challenging tasks due to the MAV wing size limitation, limited energy budgets, complicated morphing mechanism and complex aeroelastic interactions. These issues had restricted the application of morphing wing on MAV wing platform. As a result, the impact of twist morphing on MAV wing aerodynamics and structural performances was not fully understood. Thus, this thesis presents the investigation of wing structural, aerodynamics performance and flow structure formations on a basic twist morphing MAV wing named as Twist Morphing wing. A series of morphing force intensity was imposed on Twist Morphing wing design to elucidate the impact of twist morphing mobility. Fully coupled Fluid-Structure Interaction (FSI) simulation is the main methodology used in this works. The wing structural and airflow field problems over Twist Morphing wing were solved based on a three-dimensional (3D) linear quasi-static structural coupled with steady state, incompressible Reynolds Averaged Navier Stokes - Shear Stress Turbulence (RANS--SST) flow. The validation on aerodynamic performances showed good correlation between the FSI and wind tunnel test results. The wing structural results showed that Twist Morphing wings had produced high geometric twist magnitude (ϕ), which in turn, induced higher lift coefficient (Cl) and drag coefficient (Cd) performances on the wing. The flow structure investigations revealed that this benevolent and malevolent aerodynamics attitude contributed by low-pressure intensity and strong tip vortex (TV) strength induced on Twist Morphing wing. These phenomena had turned out greater in Twist Morphing wing with higher morphing force (5N and 3N) configurations. However, Twist Morphing wing had also exhibited poor maximum aerodynamic efficiency (C_l/C_m max) performances. The massive drag coefficient distribution had overwhelmed the successive increase in lift coefficient generation, which consequently plunged the maximum aerodynamic efficiency distribution magnitude on Twist Morphing wings. Hence, a multifidelity data Metamodel Based Design Optimization (MBDO) study was conducted to improve the maximum aerodynamic efficiency distribution on Twist Morphing wing. The optimal aerodynamic efficiency for Twist Morphing wing achieved at C_l/C_m max= 6.05 with angle of attack, morphing force and velocity magnitude set at 4.6°, 2.31 N and 9.42 m/s, respectively. Detail investigation on optimization outcome showed that the optimal Twist Morphing wing exhibited better maximum aerodynamic efficiency magnitude than the non-optimal flexible wings. This is due to weak tip vortex strength, which induced low drag coefficient magnitude on the optimal Twist Morphing wing.

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 synthesize 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 electrodeposition 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.