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Article / Book Information

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種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

専攻:	Chemistry and	専攻
Department of	Materials Science	
学生氏名:	TRAN Van Nam	
Student's Name		

申請学位 (専攻分野):	博士	Engineering
Academic Degree Requested	Doctor of	
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

Nowadays, stainless steel is widely used in construction of bridges and buildings because of its excellent corrosion resistance. However, stainless steel may suffer with corrosion in environments especially containing halide ions. Airborne chloride salt causes corrosion of stainless steel in seashore areas. Even though duplex stainless steel has the excellent corrosion resistance, ferritic or austenitic stainless steels usually preferred from economic point of view. Therefore, investigation of a mechanism of corrosion of ferritic and austenitic stainless steels under environments containing halide ions is important.

In marine atmospheric environments, airborne salts are deposited on the stainless steel surface. At night, water vapor condenses to form droplets containing chloride on the stainless surface due to increasing relative humidity and declining temperature. During the daytime, the chloride ion concentration increases due to water evaporation. Water droplets/films with highly concentrated chloride solution cause pitting corrosion. The previous researches reported that critical concentration of chloride ion ($[Cl^-]$) for occurrence of pitting corrosion is *ca.* 5M and 6M on stainless steel type 430 and 304, respectively. However, detailed investigation of the effect of droplet dimensions (thickness, diameter) on probability of occurrence of pitting corrosion is lacking. There is no report on the effect of cathodic reactions on pitting. Actually, the cathodic reaction is a key factor for pitting corrosion. There are many reports on the study of a mechanism of corrosion by immersing the sample into bulk solution. However, the corrosion process under droplets (thin solution layers) is quite different from that in the bulk solution. Electrochemical techniques are very often used for evaluation of corrosion resistance of metallic materials and the mechanistic studies.

In addition, composition and structure of passive film formed on the stainless steel surface play as an index to its corrosion resistance, it is well known that chromium is one of the most beneficial elements for corrosion protection. There are lots of researches to improve chromium contents on the material surface by coating, planting, etc. In addition, the inclusions on the metal surface play as the preferable sites for occurrence of corrosion. Corrosion resistance of stainless steel will be improved with decreasing the surface inclusions. Nitric acid solution is employed as a common solution for improving the corrosion resistance in the both sites, industry and study. However, this solution is toxic with not only dilute but also concentrated content. Therefore, finding a non - toxic method has been posed urgently. The achievements of this thesis can be summarized chapter - wise as below:

Chapter 1 “General information” introduces the general information in stainless steels and its corrosion, especially pitting corrosion, which is a common and dangerous form of corrosion of stainless steels. Extensive literature is reviewed to point out the important issues for investigating on this phenomenon.

Chapter 2 “Pit Initiation and Repassivation of Stainless Steels Exposed to Cyclic Relative Humidity Changes” presents a novel and convenient method to measure the pitting corrosion potential under wet-dry cyclic condition by using silver wire as the reference electrode. Under the cyclic change in the relative humidity (RH) between 95% and 45%, the solution layer thickness changed from ca. 1 mm (2M [Cl⁻] at 95%RH) to about 0.23 mm (8.6M [Cl⁻] at 45%RH). The corrosion potentials of stainless steel were simultaneously monitored. The results show that, the relative humidity ranges for occurrence of pitting (RH_{pit}) and repassivation (RH_{rep}) are 68%- 48% and 67%-73%, respectively. Besides, the RH_{pit} and RH_{rep} ranges are 58%-47%; 56%-70% for SS304, and 63%- 50%; 61%-72% for SS303, respectively. In addition, an increase in temperature resulted an increase in both RH_{pit} and RH_{rep}.

Chapter 3 “Pitting Corrosion of Stainless Steel 430 in The Presence of Thin MgCl₂ Solution Films: Effects of Film Diameter and Thickness”, the pitting corrosion under droplet conditions for SS430 is discussed. The effect of chloride concentration, RH and droplet parameters like diameter, thickness is studied. The results show that when the relative humidity exceeds 85%, no pitting corrosion occurs under solution films regardless of thickness and diameter. On the other hand, the pitting corrosion probability decreases when the solution film diameter and thickness decrease. No pitting corrosion occurred when the solution film diameter was approximately 1 mm, irrespective of solution film thickness and RH. Finally, a decrease in solution film thickness is supposed to suppress the anodic dissolution from nucleated pits, and a decrease in diameter is expected to reduce the effective cathodic area for pit growth.

Chapter 4 “Effect of MnS Inclusions on Pitting Corrosion of Stainless Steel under Wet-Dry Cyclic Conditions”, the effect of MnS inclusion on the pitting corrosion phenomenon under Wet-Dry cyclic condition was investigated. From the results, inclusion parts dissolved during the wet- dry cyclic RH change to leave small pits in several micrometers. Inclusion sites plays as initial sites for occurrence of pitting corrosion.

Chapter 5 “Improvement of Pitting Corrosion Resistance of Stainless Steel Type 430 by Potential Cycling in Non-toxic Sodium Nitrate Solution” introduces a novel non-toxic pretreatment method to modify the material surface for enhancement the pitting corrosion resistance. It was improved after 450 times of potential cycles between 0.5 V and 0.9 V in 5M NaNO₃ solution with a scan rate of 5 mV/s. Micro pits with 1-2 μm were found on the specimen surface. The pitting corrosion potential increases from 0.2V (as-polished) to ca. 0.5 V in 0.5 M NaCl solution. Besides, the pitting corrosion didn't occur on the treated specimen surface under relative humidity cyclic changes between 95% and 45%.

Chapter 6 “Summary” this entire thesis is summarized.