# 学 位 論 文 の 要 旨

Study on Fe-Cr-based Brazing Filler Metals as Substitutes for Ni-based Brazing Filler Metals
Ni 基ろう代替 Fe-Cr 基ろうに関する研究

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This study focused on two types of new Fe-Cr brazing filler metals, Fe-20Cr-43Ni-10P (mass%) and Fe-20Cr-20Ni-8P-5Si-2Mo (mass%). The electrochemical characteristics of Fe-Cr brazing filler metals and joint strength and corrosion resistance of the joints brazed with those filler metals were investigated.

In chapter 1, environmental problems in recent years and significance of substitution for Ni-based brazing filler metals were explored. The purpose of this study and composition of the thesis were described as well.

In chapter 2, the microstructures and melting properties of the Fe-Cr brazing filler metals were analyzed. Electrochemical characteristics and corrosion behaviors were investigated by electrochemical tests and surface analysis techniques as well. The microstructure was composed of solid-solution phases and phosphide phases in both Fe-20Cr-43Ni-10P and Fe-20Cr-20Ni-8P-5Si-2Mo. Fe-20Cr-43Ni-10P revealed the galvanic corrosion and Fe-20Cr-20Ni-8P-5Si-2Mo was attacked locally so that cavities formed on the surface.

In chapter 3, SUS304 stainless steel was brazed with the Fe-Cr brazing filler metals. Microstructure, joint strength, fracture mechanism and the effect of the joint clearance on shear strength were investigated to understand the brazing characteristics of the Fe-Cr brazing filler metals. In the case of the joint clearance of 10 μm, owing to the diffusion of Ni or Ni and Si from the brazed layer to the base material, the diffusion layer was formed. At the same time, P and Cr added in the brazing filler metals were concentrated in the whole brazed layer and P-rich phases were formed in the brazed layer. When the joint clearance was more than 50 μm,

primary crystals and final solidified regions emerged in the brazed layers in the joints with Fe-20Cr-43Ni-10P and Fe-20Cr-20Ni-8P-5Si-2Mo. P and Cr added in the brazing filler metals were segregated and enriched in the final solidified regions so that phosphide phases with high hardness generated. The primary phase was a solid-solution phase and the final solidification region consisted of solid-solution phases and phosphide phases. For all the joints with the Fe-Cr-based and the Ni-based brazing filler metals, the shear strength reached a maximum value in the joint clearance of 10 μm. Fracture occurred in the interface of the diffusion layer and the brazed layer. When the joint clearance was more than 50 μm, along with the occurrence of the final solidified region, the shear strength decreased and fluctuated in a tight range of approximately 10 MPa. It was clarified that the generation of the phosphide phase is the important factor decreasing the shear strength.

In chapter 4, the corrosion resistance of stainless steel joints brazed with the Fe-Cr brazing filler metals was investigated. The corrosion behaviors of the joints were analyzed and compared by means of morphology of corrosion attack, quantitative analysis and penetration depth. This chapter also aimed to explore the reasons for the change in corrosion resistance of the brazed joints. The microstructures of the fillet areas of the joints were also made up of primary crystals and the final solidified region. Corrosion attacks occurred only in the final solidified regions in the fillet areas. Corrosion was self-corrosion of the final solidified regions in the joints with the Fe-Cr-based brazing filler metals. For the joint brazed with Fe-20Cr-43Ni-10P, along with the corrosion of coarse solid-solution phases, the phosphide phases which act as the cathode were almost retained, leading to the increasing of the area ratio of the cathode to the anode. As a result, corrosion was accelerated with corrosion time and poor corrosion resistance was showed. For the joint brazed with Fe-20Cr-20Ni-8P-5Si-2Mo, along with the corrosion of fine solid-solution phases, the continuous phosphide phase was exposed on the surface and hindered corrosion in the deep direction as a corrosion barrier. It was clarified that the fine microstructure results in the high corrosion resistance of the joints.

In chapter 5, the main findings of this study were summarized.