

Characterization of Rust Layers on Fe-Based Binary Alloys Exposed to Cl-Rich Atmosphere by XANES measurements

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Introduction

Weathering steel has strong resistance to atmospheric corrosion. This feature is responsible for the so-called “protective” rust layer spontaneously formed on the surface of weathering steel. The properties of Cr-goethite such as cation selectivity contribute to the protective ability of the rust layer. However, the corrosion resistance of weathering steel considerably reduces in an environment of a large amount of chloride deposition. Some studies have shown that Ni is a very effective anticorrosive alloying element in a Cl-rich environment.

We have examined the XANES spectra of rust layers on Fe, Fe-Cr alloys and Fe-Ni alloys exposed to a Cl-rich environment in order to clarify the relation between the structural properties of the rust layer on weathering steel and anticorrosive alloying elements and/or chloride ions.

Experimental

The rust samples were provided from The National Institute for Materials Science. The atmospheric exposure tests of Fe, Fe-Cr alloys and Fe-Ni alloys were performed at Miyakojima, Japan. The specimens were supported horizontally under a roof during the exposure period of 2-3 years. In order to obtain the samples for XANES measurements, we scraped off the rust layer with a razor.

XANES spectra at Cl and Fe K-edge were measured in fluorescence mode at the BL-9A and in transmission mode at the BL-27B, respectively.

Results and Discussion

Figure 1 shows Cl K-edge XANES spectra of some rust samples. That of akaganéite is also shown in Fig. 1 for comparison. All spectra show a strong absorption peak (A) in the region of 2825.9-2827.4eV. The result indicates that all the rust samples contain large amount of akaganéite. The spectra of Fe-3Cr, Fe-5Cr and Fe-3Ni exhibit a shoulder peak (B) on the main absorption edge at almost the same photon energy, 2823.5eV. Therefore, some kinds of chloride other than akaganéite are contained in the rust layers on the alloys having relatively high corrosion rate.

We previously found by X-ray diffraction that the rust samples are mainly composed of goethite, akaganéite, lepidocrocite, magnetite and a so-called X-ray amorphous substance, which does not give a well-defined Bragg peak. The X-ray amorphous substance must be the fine particles of the above iron oxides. In order to obtain the mole ratio

composition of the rust samples, we performed the pattern-fitting calculation, in which the Fe K-edge XANES spectrum of the rust sample is approximated to the superposition of those of the iron oxides. The result indicates that akaganéite is the major component of any rust layers as shown in Fig. 2.

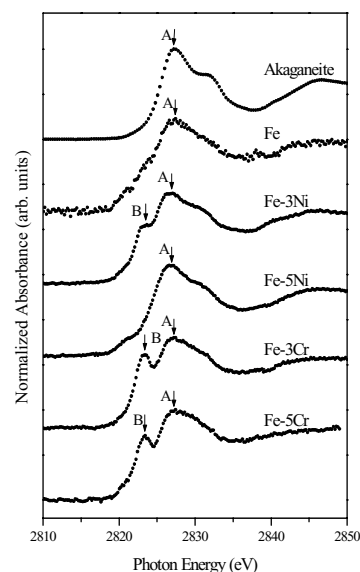


Fig. 1 Cl K-edge XANES spectra of akaganéite and the rust samples formed on Fe and Fe-based binary alloys.

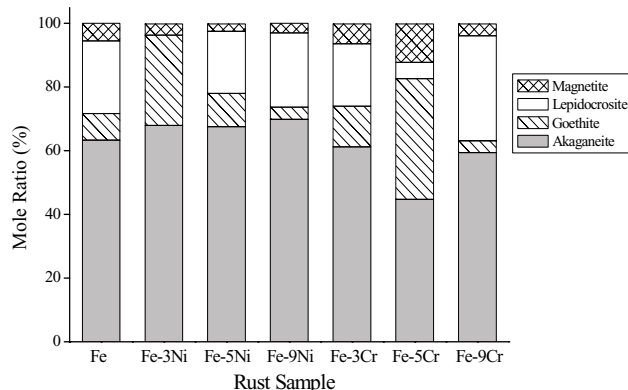


Fig. 2 Comparison of mole ratios of iron oxides in the rust samples obtained by pattern-fitting calculations of the Fe K-edge XANES spectra.

References

[1] H. Konishi et al., Mater. Trans. 46, 329 (2005).

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