

THE DEPENDENCE OF CORROSION OF FE-CR ALLOYS TO THE APPLIED THERMAL PROCEDURE: A TECHNICAL NOTE

A. ABBAS AKSÜT

University of Ankara, Faculty of Science, Department of Physical Chemistry, Ankara-Turkey

(Received in July 1985, Accepted December in 1985)

ABSTRACT

The corrosion of a material is dependant upon its composition and applied thermal procedure as well as other factors (shreir, 1976; Uhlig, 1971; Grafen et al. 1978). The effect of applied thermal procedure upon the corrosion of Fe alloys which consisted varying amounts of Cr in the medium of 1N H₂SO₄ by using various electrochemical techniques was investigated before (Aksüt, 1983). The composition of the steels investigated are tabulated in table 1.

Table 1: Composition of the alloys used

Specimens	Chemical composition wt. %		
	Cr	C	Si
Fe	0.21	0.013	0.047
3 % Cr-Fe	3.24	0.023	0.083
6 % Cr-Fe	6.33	0.024	0.010
12 % Cr-Fe	12.41	0.004	0.044
15 % Cr-Fe	14.68	0.054	0.024

The steels which compositions are tabulated in table 1, were treated with two different thermal procedure described below, under vacuum.

a) The samples were kept at 1050°C for two hours and cooled down at a rate of 150°C/hour

b) The samples were kept at 750°C for two hours and cooled down rapidly.

The corrosion rate in Fe-Cr alloys is claimed to increase by the increase in percentage of chromium (Basiouny et al, 1976). However in our study (Aksüt, 1983) this rate increased or decreased by the % Cr depending upon the thermal procedure employed. If the Fe-Cr alloys are kept at 1050°C for two hours and cooled down at a rate of 150°C/hour the corrosion rate decreased upto 9 Cr and then begins to increase above this percentage. On the other hand the corrosion rate is seen to decrease with the percentage of chromium (Aksüt, 1983) in

the samples which are kept at 750°C for two hours and cooled down rapidly. This situation was explained by the formation of carbide. Because during the cooling process of Fe-Cr alloys there is strong probability of carbide precipitation (Grafen et al, 1978; Rockel, 1971) In order to verify this the carbide formation upon the steel samples used in the experiment, they were investigated by an electron microscope. In order to do that electrode surfaces were brightened by platinum paste and corroded in 2,5 % oxalic acid solution at 3V/90s conditions and the steel surfaces were examined by an electron microscope.

The surface photographs showing the dependence of Fe-Cr alloys upon the thermal procedures are given in figure 1 and 2. The carbon distribution at the surface is shown in figure 3.

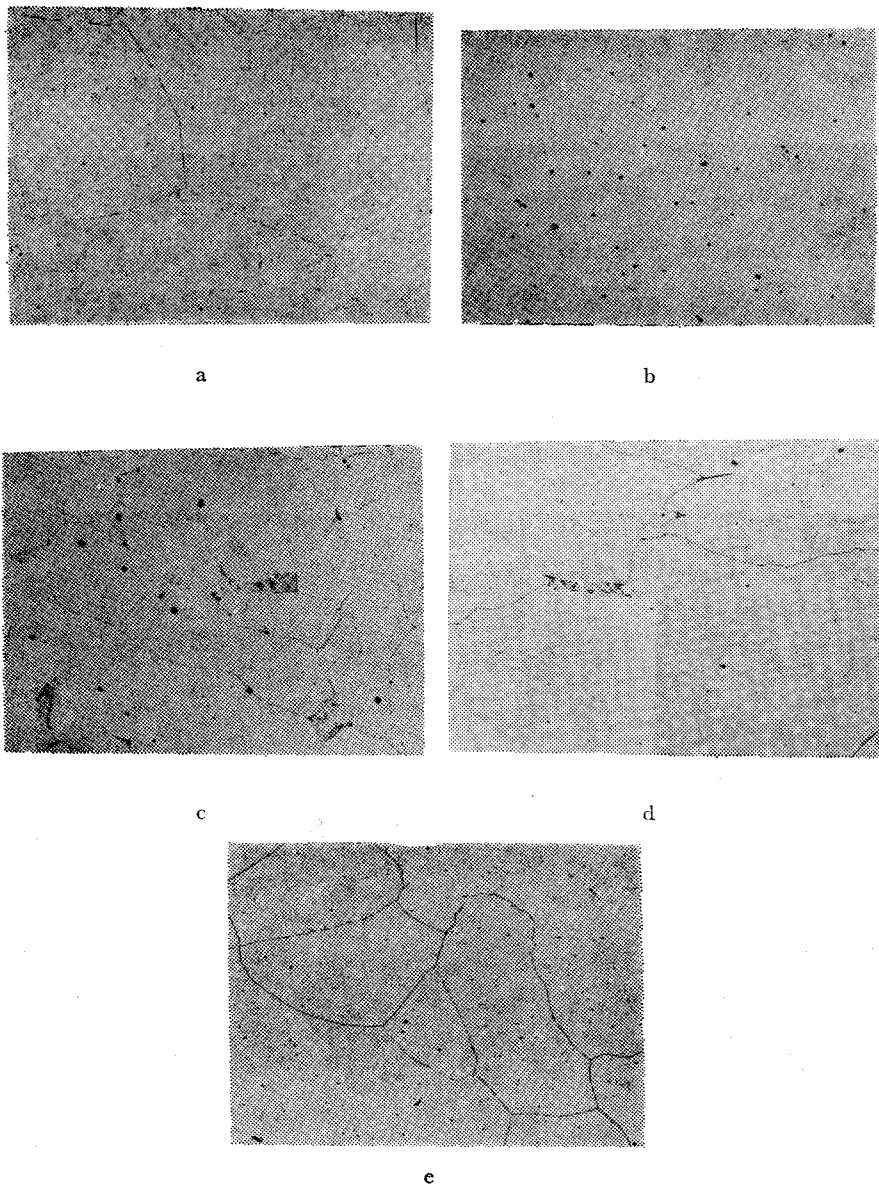


Fig. 1: The surface photographs of Fe-Cr alloys kept at 1050°C for two hours and cooled down at a rate of 150°C/hour, taken by an electron microscope. a) Fe, b) 3 % Cr-Fe, c) 6 % Cr-Fe, d) 12 % Cr-Fe, e) 15 % Cr-Fe, Compo., 100 x.

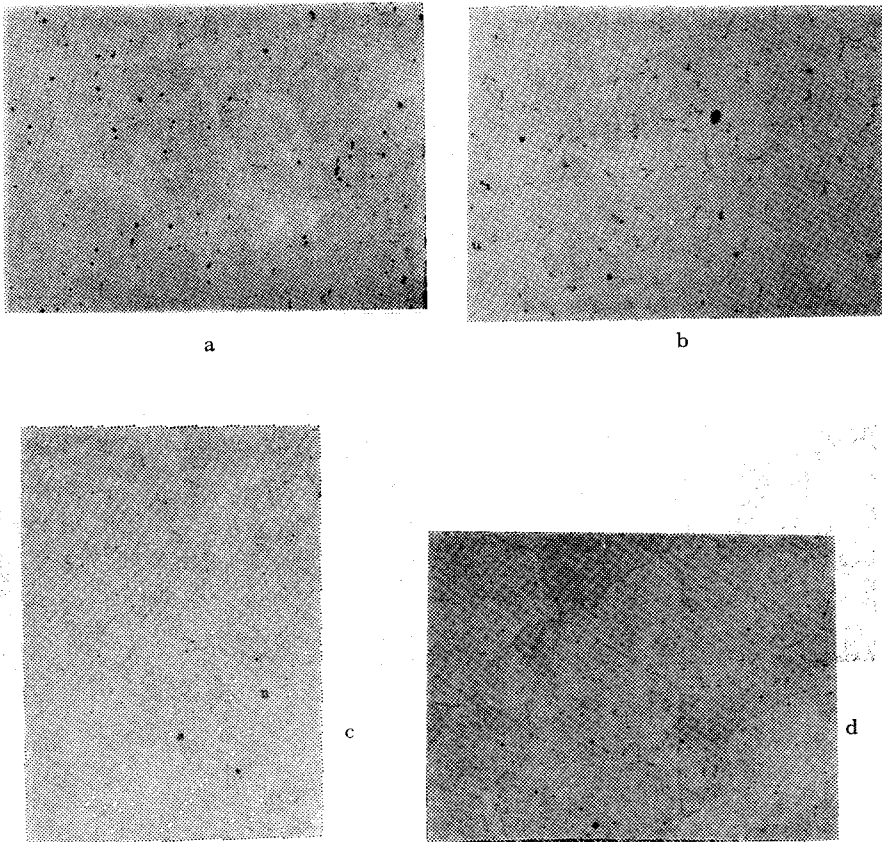


Fig. 2: The surface photographs of Fe-Cr alloys kept at 750°C and cooled rapidly, taken by an electron microscope. a) 3 % Cr-Fe, b) 6 % Cr-Fe, c) 12 % Cr-Fe, d) 15 % Cr-Fe, Compo., 400 x.

Figures 1 and 2 show that the surface grains of the alloys kept at 1050°C for two hours and cooled down slowly, are large and irregular while the surface grains of alloys kept at 750°C and cooled down rapidly are relatively small and regular.

As seen in figure 3 the carbon distribution in corroded surface depends on the thermal procedure employed. This difference in the distribution of carbon is especially observed in steels consisting 12 % and 15 % Cr (Fig. 3). The carbon distribution is found to be higher in alloys heated up to 1050°C and cooled down slowly than those heated up to 750°C and cooled down rapidly. This shows that carbon leaves as carbide at the grain boundary in slow cooling conditions. This also effects the corrosion of Fe-Cr alloys. A part from that the difference in the size and distribution of the grains at the surface has an influence upon the corrosion.

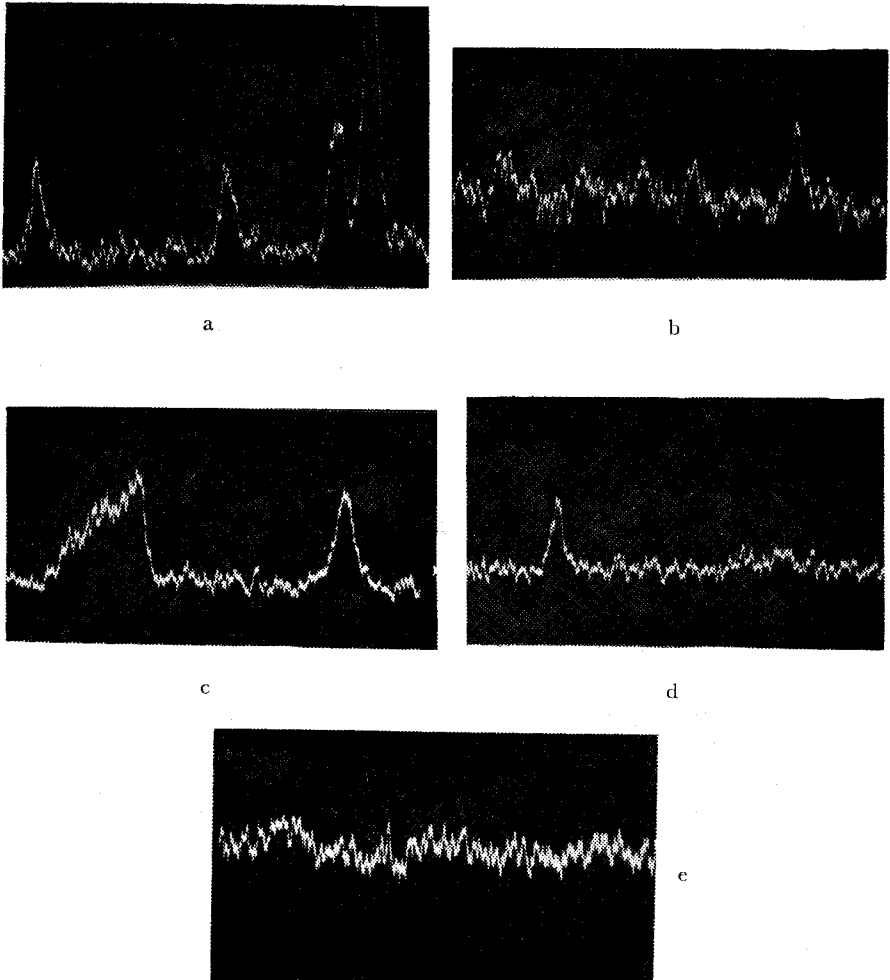


Fig. 3: The carbon distribution at the surface of Fe-Cr alloys. In steels containing 15 % Cr a (1050°C), b (750°C), in steels containing 12 % Cr c (1050°C), d (750°C) and in steel 3 % Cr e (1050°C), 2000 x.

ACKNOWLEDGEMENT

This study was financially supported by International Atomic Energy Agency and carried out at the Research Center Seibersdorf, in Austria. I would like to express my deep gratitude to Atomic Energy Agency for its financial backing and Mr. G. Groboth for carrying out the experiments.

REFERENCES

- AKSÜT, A.A., 1983. *Electrochimica Acta*, 28, 1383
- EL-BASIOUNY, M.S. and HARUYAMA, S., 1976, *Cor. Sci.* 16, 529.
- GRAFEN, H., GRAMBERG, U., HORN, M. and MATTERN, P., 1978. Kleine Stahlkunde für den Chemieapparatebau, VDI, Germany.
- ROCKEL, M.B., 1971 *Corrosion*, 27, 95.
- SHREIR, L.L., 1976, Corrosion Vol. 1 and 2, *Neynes-Butterworths*.
- UHLIG, H. 1971., Corrosion and Corrosion Control, *J. Wiley and Sons Inc.*