The Effect of Surface Finish on Pitting Corrosion

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A variety of surface finishes are available for commercial stainless steel for applications in architecture and domestic use. Surface finishing also affects localized corrosion and passivity. Currently, a number of tests are used for ranking pit susceptibility for different surface finishes, for example salt spray testing and critical pitting temperature measurements [1]. However, these can be quite slow. This work aims to investigate electrochemical methods for assessing the pitting susceptibility of stainless steel with different surface finishes.

Visualizing corrosion using indicator and agar gel has been used for studying on the corrosion of Al, Al alloys and corrosion of stainless steel [3]. This work develops this method for assessment of stainless steel surfaces with different surface finishes. In this method, ferroxyl indicator [4] is used to detect pitting. The indicator is dissolved in agar gel, together with chloride ions to promote corrosion. The corrosion can be driven either by potentiostatic or galvanostatic control. During corrosion, the indicator changes color from yellow to blue as a result of reaction with Fe^{2+} ions formed at pitting sites. It is possible to use image analysis to determine the fraction of the surface that is blue, which gives a semi-quantitative value to the corrosion susceptibility of the surface.

Six commercial surface finishes on 304 stainless steel were used for assessment (Table 1). During potentiostatic polarization at +250 mV(SCE), blue spots appeared around pits (Figure 1).

Table 1. Six commercial surface finishes of 304 stainless steel

Surface	Description
A	180 grit alumina; brushed
B	240 grit alumina
C	180 grit alumina
D	240 grit SiC
E	280 grit SiC
F	brushed

Table 2. The number of blue dots and blue area on the gel after potentiostatic measurement of six commercial surface finish with an applied potential of 250 mV/SCE for 15 minutes

Gel	F	D	A	B	E	C
Blue area (area/cm^2)	0.02	0.26	0.4	2.85	6.01	11.32
Number of blue dots	6	15	15	73	61	158

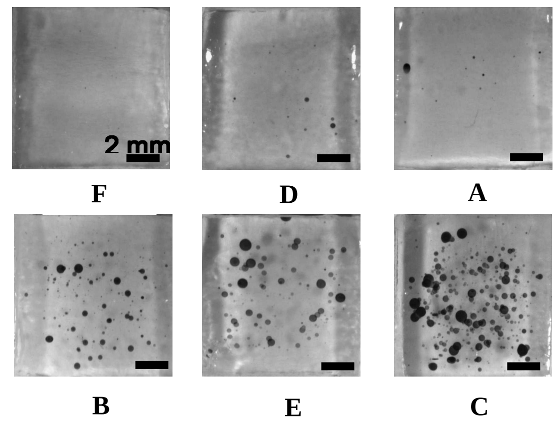

Figure 1. The ranking corrosion susceptibility of gel after potentiostatic measurements applied potential 250 mV/SCE for 15 minutes on the six commercial surface finishes

The current measurements made during potentiostatic polarization correlate well with the gel images as shown in Figure 2. Surfaces C, E and B gave relatively high anodic currents while surfaces A, D and F gave much lower anodic currents. These results correlate well with the results of salt spray tests.

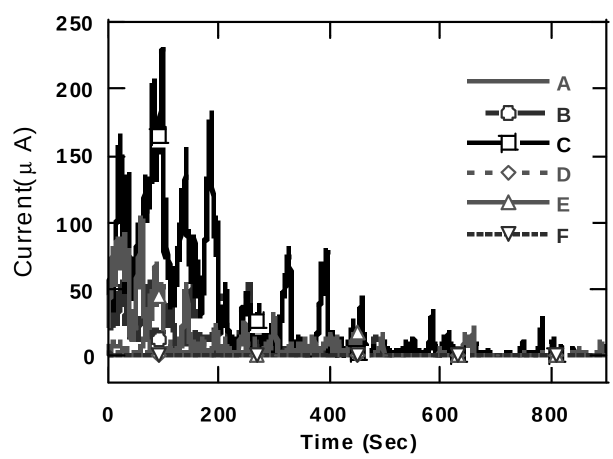

Figure 2. Potentiostatic measurements of the six commercial surface finishes of 304 stainless steel at applied potential 250 mV/SCE for 15 minutes of under the gel measurements

Reference:

[1] R.J. Brigham and E.W. Tozer, Corrosion, 29, 33 (1973)
[2] H.S. Isaacs, G. Adzic and C.S. Jeffcoate, Corrosion, 56, 971 (2000)
[3] P. Freeman, Private communication
[4] U.R. Evans, The Corrosion and Oxidation of Metals: Scientific Principle and Practical Application, Edward Arnold Pub.Ltd, London (1960)