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Bipolar Electrochemistry for High-throughput Corrosion Screening

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In this work it is demonstrated that bipolar electrochemistry can be used for high-throughput corrosion testing, covering a wide potential range in one single experiment. This technique, combined with rapid image analysis, constitutes a simple and convenient way to screen corrosion behaviour of conducting materials and corrosion protective coatings.

The bipolar effect arises when an electronic conductor is isolated in an electrolyte and is subjected to a sufficiently high electric field. In this case an electrochemical potential gradient is formed across the surface of the electronic conductor, which induces anodic and cathodic reactions depending on the potential at any given point[1-3]. This effect is schematically depicted in Figure 1.

Stainless steel samples (SS304), acting as bipolar electrodes, were immersed in sulfuric or hydrochloric acid and exposed to an electric field to establish a potential gradient along the surface of the sample. In this way, the same steel sample was exposed to a wide range of cathodic and anodic conditions, ranging from potentials yielding hydrogen evolution to potentials well into the trans-passive region.

This wireless approach enables rapid simultaneous comparison of numerous samples, and also provides the opportunity to perform experiments on samples that are of a complex shape, or which are otherwise difficult to employ in standard electrochemical corrosion tests. An SEM image of an example of a typical pitting corrosion gradient on a bipolar electrode of SS304 in hydrochloric acid is shown in Figure 2. The size of the pits increases towards the left in the image, which is at the anodic end of the sample.

Acknowledgements

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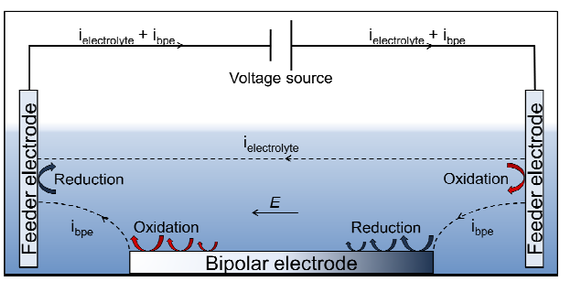

Figure 1: Schematic picture of the bipolar setup.

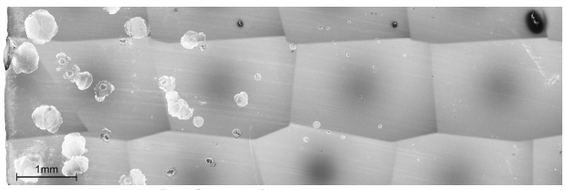

Figure 2: Example of a gradient in pitting corrosion.

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