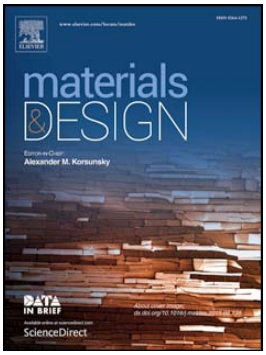

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Digital holographic microscopy as a new technique for quantitative measurement of microstructural corrosion in austenitic stainless steel

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Abstract

The aim of this paper is to introduce reflective digital holographic microscopy (rDHM) as a new method for quantitative evaluation of corrosion. Despite the commonly-used evaluation methods, rDHM does not require scanning, while it measures the microstructural height profile of the corroded sample surface within a macroscale area. Based on the height profile across the corroded grain boundaries, a quantitative criterion is suggested to distinguish between intergranular and transgranular corrosion. The experimental results show the capability of rDHM to analyse the microstructural corrosion in AISI 304 stainless steel. The presented method can also be applied as a surface characterization method for analysis of a variety of metallurgic effects such as crystal elasticity and crystal orientation.

Keywords: reflective digital holographic microscopy, austenitic stainless steel, intergranular corrosion

1. Introduction

Austenitic stainless steels are often a proper choice for numerous applications. They are used in different industries such as food, power, oil and petrochemical industries. These corrosion resistant materials provide a considerable mechanical strength and formability together with high work hardening exponent.[1–3]

When austenitic stainless steel is heated in the critical temperature range (500 to 800°C) for a certain time span [4], chromium carbide is precipitated at unstable and high energy regions of the grain boundaries. Intergranular corrosion (IGC) is caused by sensitization or micro-galvanic coupling between the grain boundary (GB) and the bulk-grain interior in which the GB is often the anode. Precipitation of chromium carbide in the grain boundaries together with depletion of chromium in the zones adjacent to the boundaries is known as sensitization [4–6]. Whenever sensitized austenitic stainless steel is exposed to specific aggressive environments, it suffers IGC. Such situations happen in industrial facilities such as heat exchangers, boilers, and pipelines in corrosive sites including chemical plants and oil refineries. [5, 7] Sensitization may happen not only during operation, but also during fabrications that operate at high temperatures, such as hot forming processing, heat treatment, and welding [8, 9].

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