THE EFFECT OF HYDROGEN ON THE PROPERTIES OF DUPLEX STAINLESS STEEL

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Introduction

Duplex stainless steels with a two phase austenite/ferrite microstructure have excellent mechanical properties and a high corrosion resistance. However, they are susceptible to hydrogen induced degradation. In this work, the interaction between hydrogen (H) and a 50/50 duplex stainless steel was investigated.

Material characterisation

<table>
<thead>
<tr>
<th>C</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
<th>Mn</th>
<th>Si</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.013</td>
<td>22.45</td>
<td>5.31</td>
<td>2.63</td>
<td>1.81</td>
<td>0.38</td>
<td>Cu 0.24, P 0.02, S 0.005</td>
</tr>
</tbody>
</table>

Austenite fraction = 50.0 ± 1.5 %

Hydrogen/metal interaction

0.8 mA/cm² in 0.5M H₂SO₄ and 1 g/l thiourea

Total hydrogen content (melt extraction)

\[ C_{\text{H}} = 680 \text{ wppm} \]

\[ D_{\text{app}} = 1.64 \times 10^{-14} \text{ m}^2/\text{s} \]

\[ D = 1 \times 10^{-14} \text{ m}^2/\text{s} \]

Constant temperature hydrogen desorption tests

\[ D(RT) = 1.48 \times 10^{-14} \text{ m}^2/\text{s} \]

Conclusions

- A saturation level of 680 wppm was obtained after approximately 10 days of charging
- A diffusion coefficient of \(1.64 \times 10^{-14} \text{ m}^2/\text{s}\) was found by melt extraction; \(1.48 \times 10^{-14} \text{ m}^2/\text{s}\) was found from hydrogen desorption tests
- Slip bands were generated during hydrogen charging
- Correlation between H affected zone and H diffusion distance was found

Mechanical properties

Air

\[ 40-45 \mu \text{m embrittled layer} \approx \sqrt{D \cdot t} = 36-38 \mu \text{m} \]

Ductility loss

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