Evaluation plan for Hydrogen Compatibility of Aluminum alloys

Transmitted by Japan
4th Meeting of the informal working group on GTR No.13 (Phase 2)
16-18 October 2018 @ Brussels, Belgium
### Action Items for 3rd GTR No.13 IWG Meeting

**From the Meeting Notes of 3rd GTR No.13 IWG Meeting**

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<thead>
<tr>
<th>Topics</th>
<th>Discussion</th>
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<th>Due Date</th>
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<tr>
<td>HG-SCC (Aluminum)</td>
<td>• Industry and CP requesting data on validating this test method such that it does not limit aluminum alloys that could be appropriate</td>
<td>• JARI to provide update plan on future testing (e.g., in humid H2 conditions)</td>
<td>JARI</td>
<td>Next IWG mtg (OCT)</td>
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</table>
Material selection: SSRT Characteristics in humid air

- **7075** is affected by humid air in SSRT test
- **6061** is not affected by humid air

⇒ In humid hydrogen gas, SSRT Characteristic of aluminum alloy is unknown.

![Graph 1: Stress (σ) vs Strain (ε) for 7075-T6](image1)

![Graph 2: Stress (σ) vs Strain (ε) for 6061-T6](image2)

**Fig.1** Stress (σ) – strain (ε) curves on the SSRT test for alloy 7075-T6.

**Fig.2** Stress (σ) – strain (ε) curves on the SSRT test for alloy 6061-T6.

Specimen selection: Influence of specimen's thickness

◆ When the specimen is 5.0mm thick, 7075 is not affected by humid air.

⇒ The specimen with 1.0mm thickness is appropriate for testing.

— Fuel cell vehicles, Distributed fuel cell system installed into houses, Hydrogen infrastructures —— Basic Research on Aluminum-Based Materials for Hydrogen
Test temperature selection:
Estimation of frost point in High pressure H₂ gas

- **70MPa, 5ppm frost point**: -28°C
- **In the case of 56MP, -40°C**, condense even at 2ppm
- **10MPa • 5ppm frost point**: -33°C

**Fig.5 Estimation of frost points for water concentration 1~5 ppm, total pressure up to 95 MPa.**


https://doi.org/10.2963/jjtp.28.121
Verification test plan

◆ Purpose : Investigation of influence of humid hydrogen gas in SSRT test

◆ Test condition :
  Pressure : 10MPa Hydrogen
  humidity : Dry (Pure Hydrogen: Grade1 (7N),
              frost-point : -80℃)
  Humid (Hydrogen gas include 5ppm H₂O)
  Temperature : approx. -30℃ (Relative Humidity ≈ 100%)
  Material : 6061-T6, 7075-T6
  Specimen : 1mm thickness sheet specimen

◆ Schedule :
  August.2018 : Prepare Materials (6061-T6, 7075-T6)
  September.2018 : Prepare specimens
  After October.2018 : SSRT Test
Result image of SSRT test in humid hydrogen gas (1)

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<th>7075</th>
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<td>• Dry H₂ gas (-30℃, Frost point:-80℃)</td>
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<td>• Humid H₂ gas (-30℃, 5ppm H₂O, RH90%)</td>
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◆ When the influences of both in air and in hydrogen gas are the same, it is enough to evaluate humid gas influence only in humid air.

◆ Materials affected by humid gas SSRT are estimated to be affected by HG-SCC test as well.

⇒ To select materials,

HG-SCC test in humid air (Room temp., RH90%) + SSRT, fatigue Test in dry hydrogen gas
Result image of SSRT test in humid hydrogen gas (2)

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◆ 5ppm H₂O may not affect the SSRT test result in hydrogen.

◆ However, 5ppm H₂O may affect the HG-SCC result in hydrogen and in air.

⇒ It may be necessary to perform the HG-SCC test in hydrogen and/or in air with 5ppm H₂O.
Additional consideration for future plans

◆ Subject:
Is it possible to evaluate correctly the phenomenon of stress corrosion cracking in humid hydrogen environment by the SSRT test?

JARI will plan another test by the specimen with notch or pre-crack as fracture test in humid hydrogen.

◆ Overall schedule:
1\textsuperscript{st} step: End of 2018
⇒ SSRT test by sheet specimen

2\textsuperscript{nd} step: TBD (After confirmation of 1\textsuperscript{st} step results)
⇒ e.g.)
⇒ SSRT test by specimen with notch or pre-crack in humid hydrogen.
Thank you for your kind attention