



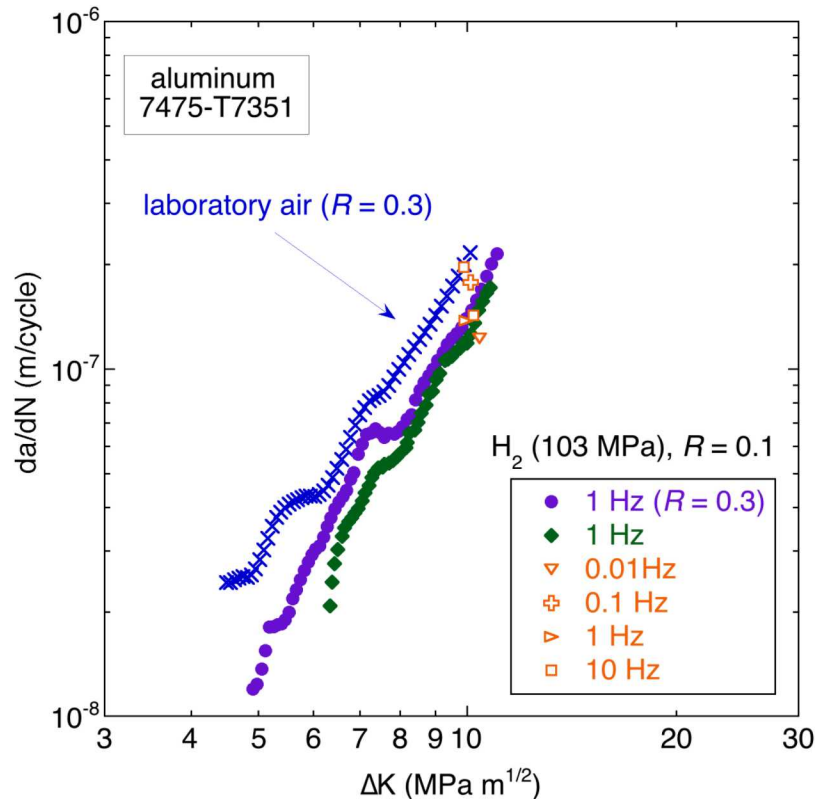
# Testing to establish suitability of aluminum alloys for use in fuel cell-grade hydrogen

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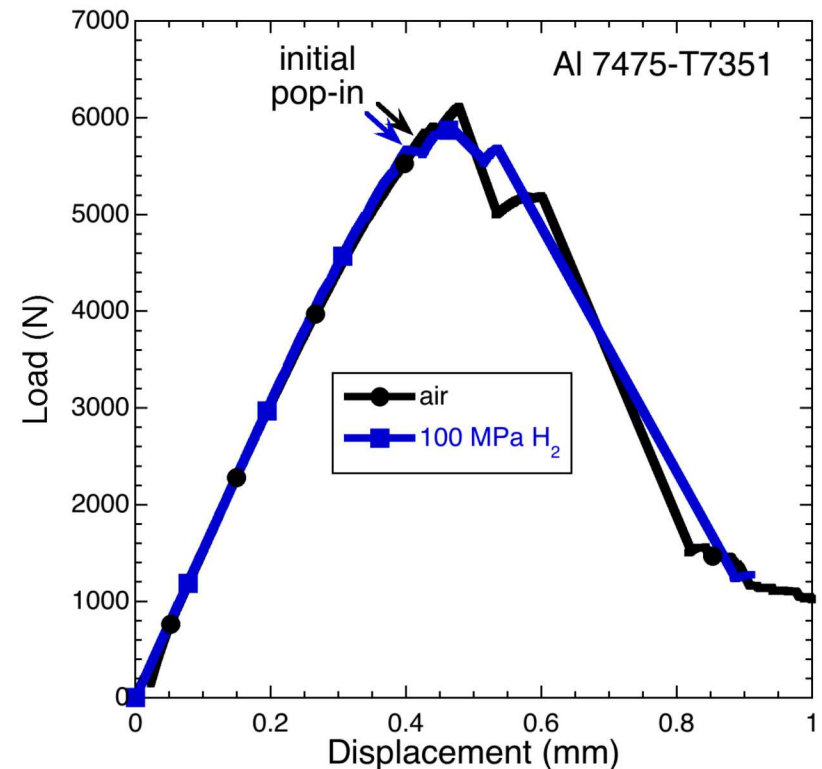
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In support of informal SAE and GTR discussions

# Aluminum alloys are seemingly immune to hydrogen

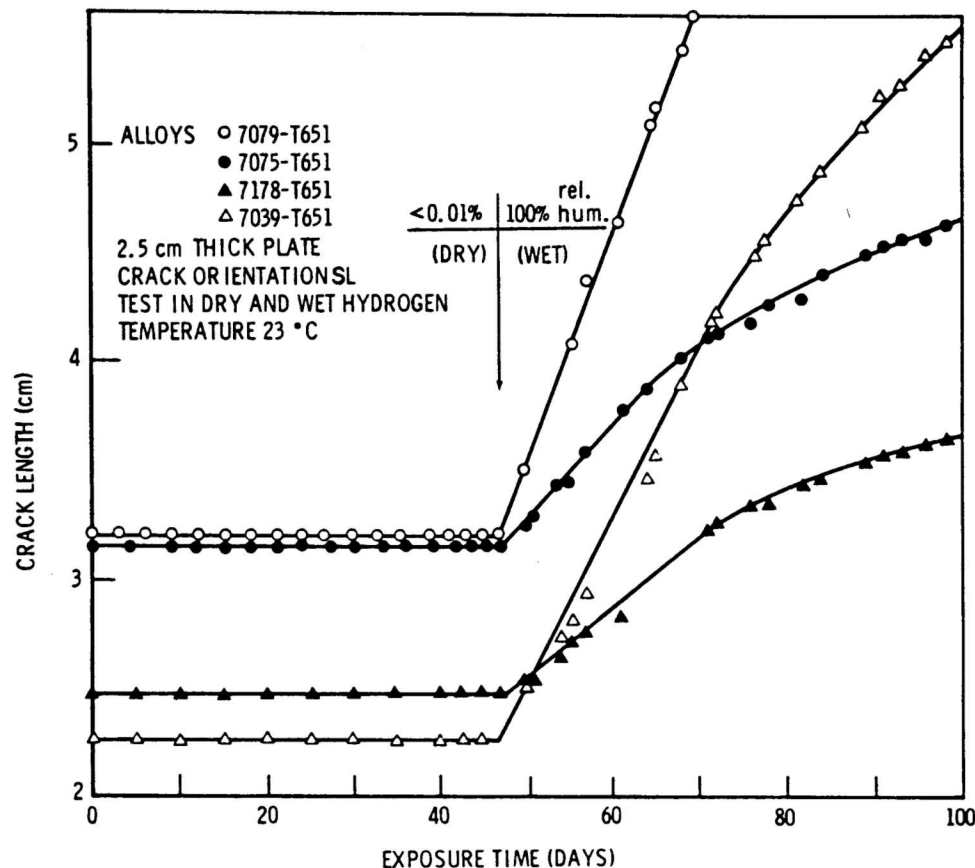


**Fatigue crack growth rates in H<sub>2</sub> are less than in air**



**Fracture resistance is nominally the same in H<sub>2</sub> and in air**

# Cracking of aluminum alloys is “activated” when moisture is added to hydrogen



From: Speidel, Hydrogen Embrittlement and Stress Corrosion Cracking, 1984

- Seminal experiments show clear difference of fracture resistance in dry H<sub>2</sub> and wet H<sub>2</sub>
- There are no data that show fracture and fatigue of Al alloys are affected by dry H<sub>2</sub>

**Moisture in H<sub>2</sub> can promote environment-assisted cracking**

# What conditions are needed for moisture to play a role in environment-assisted cracking of aluminum alloys in high-pressure gaseous hydrogen?

**SAE J2719 limits moisture content to 5 ppm in fuel-cell grade H**

- **Is 5ppm H<sub>2</sub>O in high-pressure H<sub>2</sub> sufficient to induce stress corrosion cracking (SCC) in high-strength aluminum alloys?**

## **Scientific questions:**

- **Is there a threshold of moisture needed to induce SCC?**
- **What are the surface conditions and mechanisms necessary for SCC in hydrogen environments?**



# Testing plans

- **Materials**

- 2219 – T8511
- 7050 – T7
- 7475 – T7

- **Environment: P = 100 MPa**

- Pure H<sub>2</sub> (<5ppm H<sub>2</sub>O)
- H<sub>2</sub> + 100 ppm H<sub>2</sub>O

- **Mechanics**

- Constant displacement fracture mechanics tests (SCC tests)
  - ASTM E1681 (nominally equivalent to ISO)
- Fatigue crack growth
  - If necessary, to explore role of “oxide-free” surfaces

