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## 2026 ACA Foundation Scholarships

Thanks to the generous support of some Corporate ACA Members and the ACA Foundation (ACAF) Centurions, there will be 16 ACAF Scholarships available this year to provide financial support to the successful applicants to attend an ACA Conference or Training Course. Of these, three are reserved for NZ applicants being;

- **The Ray Osborne Memorial Scholarship** for a YCG member, which is sponsored by Universal Corrosion Coatings
- **The Metspray Scholarship** for an applicant from the protective coatings industry
- **The Carboline NZ Scholarship** to attend Corrosion & Prevention 26 (for which they are also the Principal Sponsor).

Application forms and scholarship conditions will be available from <https://www.corrosion.com.au/foundation/scholarships/> with applications **closing on 30 June 2026.**



*ACANZ would like to gratefully acknowledge this month's sponsor...*

### **inspection & consultancy services ltd**

With over 23 years within New Zealand and overseas we have AMMP Coating Inspectors with the Level 1 (Basic), Level 2 (Intermediate) and Level 3 (Senior/Advanced) Coating Inspector certifications, and we work extensively throughout all areas of New Zealand.

We offer Condition Assessments, Pre-commencement meetings & ITP, in-progress audit or full inspections & monitoring/auditing, and specifications and defect investigations.

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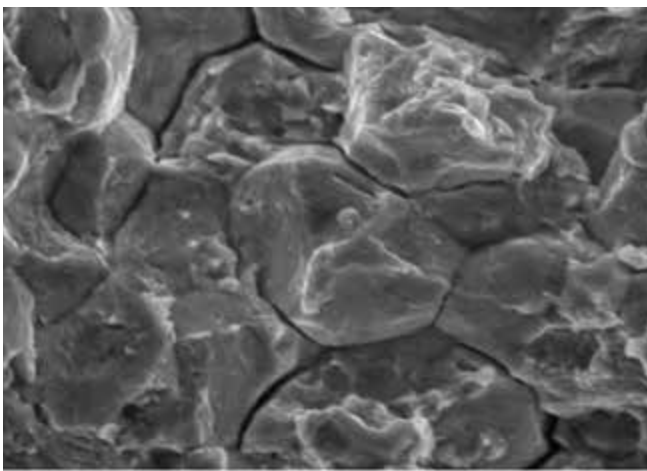
## The hydrogen economy

**The move towards a hydrogen economy is one pillar of global de-carbonisation, but it faces a significant metallurgical hurdle called hydrogen embrittlement.**

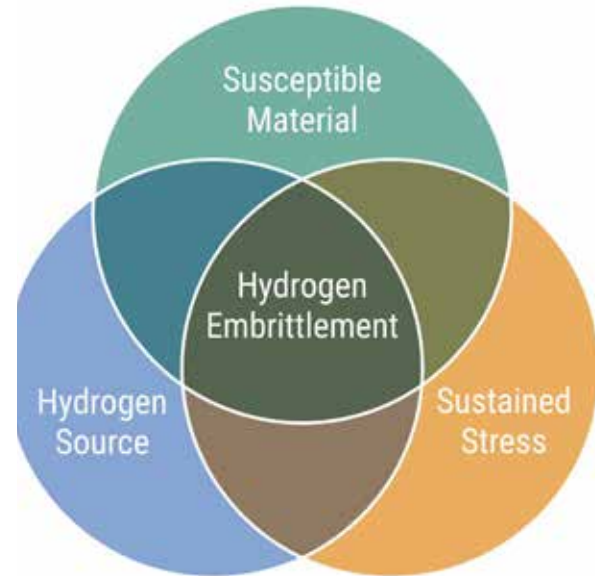
While hydrogen is a clean fuel, its interaction with metals - particularly high-strength steels - can lead to sudden structural failure. For the hydrogen economy to be viable, the “invisible” threat of embrittlement must be carefully managed. This involves strict adherence to Standards, such as ASME B31.12 for hydrogen piping, and continuous monitoring of hydrogen infrastructure to detect sub-critical cracking before a major failure occurs.

The hydrogen economy refers to using hydrogen gas (H<sub>2</sub>) as a low-carbon energy carrier for heating, transport, and industrial processes.

- **Production:** hydrogen is produced by electrolysis, splitting water molecules into hydrogen gas and oxygen gas :-  $2\text{H}_2\text{O} - 2\text{H}_2 + \text{O}_2$
- **Storage & Transport:** hydrogen has a high energy density by weight but very low density by volume. This requires high-pressure tanks or cryogenic liquefaction to be employed.
- **Infrastructure Challenges:** repurposing existing natural gas pipelines is one goal, but many older steel pipes are susceptible to the chemical effects of pure hydrogen.



*Hydrogen embrittlement (SEM micrograph) in grain boundaries of susceptible high-strength steel components, such as rock anchors, self-drilling fasteners and threaded rod*



### The mechanism of hydrogen embrittlement

Hydrogen embrittlement is a corrosion process whereby metals and alloys become brittle and fracture under stress due to the introduction and diffusion of hydrogen atoms into the material’s microstructure.

#### The hydrogen embrittlement process:

- **Adsorption:** molecular hydrogen dissociates into atomic hydrogen on the metal surface ( $\text{H}_2 \rightarrow 2\text{H}$ )
- **Absorption & Diffusion:** because the hydrogen atom is the smallest of all elements, it easily diffuses into the metal’s crystalline lattice. It tends to migrate toward areas of high tensile stress or “traps” like grain boundaries and inclusions.
- **Fracture:** Once concentrated, the hydrogen lowers the fracture toughness of the metal, which can lead to:
  - o **Internal pressure:** recombining into hydrogen molecules within voids, creating internal stress.
  - o **Lattice weakening:** reducing the cohesive strength between metal atoms.
  - o **Localised plasticity:** changing how the metal deforms at a microscopic level

The hydrogen economy - continued

### Susceptible materials and factors

Not all metals react to hydrogen in the same way. The risk of embrittlement is determined by a number of variables:

Factor	High Risk	Lower Risk
<b>Material</b>	High strength steels titanium alloys ferritic steels	Austenitic stainless steels, eg. 316L copper, aluminium
<b>Microstructure</b>	Martensitic or coarse-grained structures	Fine-grained, stable austenitic structures
<b>Stress Level</b>	High residual or applied tensile stress	Low-stress or compressive stress
<b>Environment</b>	High pressure, high temperature presence of H <sub>2</sub> S	Low pressure, ambient temperature

### Mitigation Strategies

To build reliable and durable hydrogen infrastructure, engineers employ several defence layers to mitigate the risk of hydrogen embrittlement:

- **Material Selection:** using materials like 316/316L stainless steel, which has a high nickel content that stabilises the austenite phase and slows hydrogen diffusion.
- **Surface Barriers:** applying coatings, like aluminium

or ceramics, to prevent hydrogen atoms from entering the metal lattice.

- **Inhibitors:** adding small amounts of oxygen or other gases to the hydrogen stream to occupy surface sites and block hydrogen adsorption.
- **Heat Treatment:** baking the metal after processes like electroplating or welding to drive out absorbed hydrogen before it causes damage.



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Q  
&  
A  
**CORNER**



Older ACA NZ members have probably seen a number of situations that may never have made it to a textbook.

If you have a question you'd like clarification on, email it to the Editor at [lesboultonrust@gmail.com](mailto:lesboultonrust@gmail.com). We'll pose it to our panel of experts who will answer it in another Bulletin, so everyone can improve their knowledge.

**Q: What is the role of a Forensic Engineer?**

**& A:** Forensic engineers play a vital role in investigating product failures, ensuring the safety, reliability, and performance of products and structures across many industries. By systematically gathering evidence, conducting destructive and non-destructive testing, performing laboratory analysis, and providing expert recommendations, they help companies identify and correct the cause of a failure.

This process not only helps to resolve individual incidents but it also provides industry standards, helping prevent future failures and enhancing overall safety.

The following methodology aligns with ASTM G161 "Standard Guide for Corrosion-Related Failure Analysis" and general forensic engineering best practices.

**1. On-Site Evidence Preservation**

The "forensic" nature of the investigation begins before any parts are moved. Initial steps prioritise the integrity of the evidence:

- **Photographic Documentation:** before cleaning or disturbing the site, take high-resolution photos of the failed component in situ. This captures the orientation, the presence of specific corrosion products, e.g., "green rust" or tubercles, and proximity to other metals or flow patterns.
- **Environmental Sampling:** collect samples of the electrolyte (water, soil, process fluid) and any loose scales or deposits. Forensic analysis often reveals that the standard operating environment was compromised by a transient spike in chlorides, bacteria, or temperature.
- **Data Collection:** log the precise location, service life, and maintenance history of the incident.

**2. Laboratory Examination and Characterisation**

Once the component is moved to a controlled environment, the focus shifts to the micro-level.

- **Visual and Low-Power Microscopy:** Identification of specific corrosion morphologies, e.g. pitting, crevice, exfoliation, or uniform attack.
- **Metallography:** cross-sectioning the failure site to examine the microstructure. This determines if the corrosion followed grain boundaries, e.g. intergranular corrosion, or if there are signs of stress corrosion cracking (SCC).
- **Surface Chemistry SEM/EDS:** using Energy Dispersive X-ray Spectroscopy (EDS) to identify elements within the corrosion product. For example, finding high chlorine counts at the base of a pit in stainless steel confirms chloride-induced pitting.

**3. Root Cause Analysis (RCA)**

A forensic engineering report must bridge the gap between "what" happened and "why" it happened, to identify the root cause of the failure.

*What is the role of a forensic engineer - continued*

#### 4. Key Failure Mechanisms to Rule In / Rule Out

The forensic investigator systematically tests the available evidence against known mechanisms:

- **Galvanic incompatibility:** was a noble metal (like copper) in electrical contact with a less noble metal (like aluminium or carbon steel) in a shared electrolyte?
- **Microbiologically Influenced Corrosion (MIC):** are there characteristic hemispherical pits or “sulphur” smells indicating SRB (Sulphate-Reducing Bacteria) activity?
- **Flow-Induced Corrosion:** does the wear pattern indicate erosion corrosion or cavitation?
- **Design/Fabrication Issues:** were there stagnant

areas (crevices) or high residual stresses from welding (sensitisation) that weren’t properly addressed?

#### 5. Reporting and Prevention

The final forensic report concludes with a Statement of Probability. Unlike most academic research, forensic engineering must provide a definitive opinion (the root cause) for legal, insurance, or safety reasons.

- **Corrective Actions:** recommendations typically involve material upgrades, (moving from grade 304 to 316L stainless steel), environmental controls (use corrosion inhibitors), or design modifications (eliminating crevices).
- **Prevention:** establishing a baseline for future inspections using non-destructive testing (NDT) such as ultrasonic testing (UT) to monitor thinning.

Lastly, a good forensic engineering investigation report can assist legal experts to identify the root cause of a corrosion failure without the need for costly and time-consuming court action.



*Stainless steel water tank weld corrosion leading to tank failure.*

***Why did the welds fail?***

## Choose ICS for your next coatings inspection

*Advertorial*

Inspection & Consultancy Services Ltd (known more widely in the industry as ICS) is a completely independent company that was started in 2003 by Phill Dravitski, and therefore has a solid 23+ years within New Zealand - and some international destinations - in independent coating inspections and consultancy roles for a wide range of domestic, industrial and corporate clients.

While a large amount of our work is linked to the high voltage electricity sector (including power pylon structures, power stations, substations, and other similar installations), we also work within the rest of the coatings industry including tunnels, ships, bridges, buildings, houses, transport, pipes, tanks, penstocks, training courses, and much more.

We have AMMP Certified Coating Inspectors with the Level 1 (Basic), Level 2 (Intermediate) and Level 3 (Senior/Advanced) Coating Inspector certifications, and work extensively throughout all areas of New Zealand and other international destinations as required.

Some of what we offer includes condition assessments, specifications' review or writing, pre-commencement meetings and ITP, in-progress audit or full inspections and monitoring/auditing, plus defect investigations, and tailored training/mentoring courses catering for specific tasks.



What we are finding in more recent years is the swing back to pre-start strategies and meetings to set projects on the right path before they start, and set the rules and expectations for all parties – which ultimately delivers more assurance to the asset owner that is every party's ultimate goal.

Being fiercely independent of any product supplier, applicator, or engineer, we strive to promote and specify the best products for each application that we can source within the wider industry, rather than be limited to a select range - although we have a preference to specify and promote tried and proven products that we know work in our environments.

Similarly, it does not worry us who pays the invoices as we will not be compromised or swayed to change our standard of acceptance or workmanship.

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