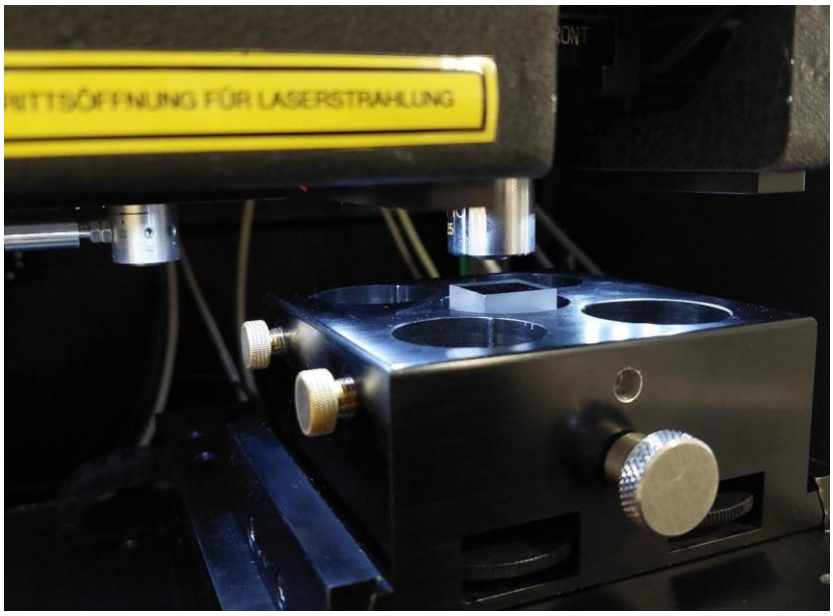
SUCCESS STORY

HYLLEY.
Research into Competitive and Practical Heavy Duty Hydrogen Engines

Program: COMET – Competence Centers for Excellent Technologies

Förderlinie: COMET-Projekt

Project: System and Materials, 1.4.2024 – 31.12.2027 strategic, multi-firm



STUDYING HYDROGEN-STEEL INTERACTIONS VIA NANOINDENTATION

THIS STUDY INTRODUCES A NEW CHARGING APPROACH FOR NANOINDENTATION TO STUDY HOW HYDROGEN AFFECTS STEEL. IT AVOIDS ISSUES ARISING IN CONVENTIONAL METHODS AND USES X-RAY DIFFRACTION TO CONFIRM HYDROGEN PRESENCE. THE NEW METHOD SHOWED THAT HYDROGEN REVERSIBLY INCREASED HARDNESS IN A FERRITIC STEEL AND PROVIDES A PLATFORM FOR MORE STABLE AND RELIABLE MEASUREMENTS

Understanding how hydrogen influences the mechanical properties of metals, is a critical issue for components involved in pipelines and hydrogen engines. In Hylley, scientists have developed a new way to test this, using a technique called electrochemical nanoindentation, where a tiny tip indents the material during hydrogen charging. The new side charging method avoids issues like corrosion which can occur in the conventional front-side charging approach. This is accomplished as hydrogen enters the sample from the side – circumvent electrolyte-sample contact in the testing area.

The researchers employed a ferritic steel and the new cell design which is easier to use than the conventional front-side charging method. They also coated the steel with a thin film of titanium to act as a "hydrogen sensor". Using X-ray diffraction, they confirmed that the hydrogen moved through the steel by detecting the formation of titanium hydride in the thin film.

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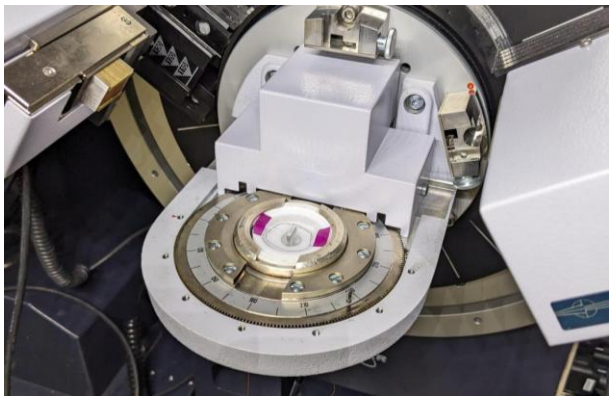

During the tests, they found that the hardness was reversibly increased when hydrogen was present. This happens because hydrogen atoms get trapped near defects in the metal, making it harder for them to move. This effect disappears when the hydrogen is removed from the steel, accomplished by turning of the current of the cell.

Impacts and Effects

This new side charging method has several advantages:

- It prevents corrosion and uses standard equipment.
- It reduces measurement errors by avoiding the hydrogen bubbles in the tested region.
- The setup is more rigid and can be used for a wider range of experiments.

While the new method is better for studying certain types of steel, it may not be ideal for all metals, especially those where hydrogen diffuses very slowly. Overall, this research provides a more reliable way to study how hydrogen affects metals, which could lead to safer and more durable materials.

Stefan Zeiler, Anna Sophie Jelinek, Velislava Terziyska, Ruth Schwaiger, Christian Mitterer, Steffen Brinckmann, Verena Maier-Kiener, A new approach for in situ electrochemical nanoindentation: Side charging as a promising alternative, Acta Materialia, Volume 276, 2024, 120113, ISSN 1359-6454, https://doi.org/10.1016/j.actamat.2024.120113.

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