



## Application Note # 63

# Determination of the $\alpha$ -martensite content in steel tanks used for storing liquid hydrogen

**Hydrogen technology as an accumulator or as a fuel offers great potential. However, cryogenic liquid hydrogen is typically stored in special steel tanks – a circumstance that presents its own safety challenges: Should the structure of the tank fail in any way, the hydrogen can escape uncontrollably and form inflammable mixtures with other elements present in the air. Therefore, material testing is absolutely essential in any quality control process for tanks used to store liquid hydrogen. With the FERITSCOPE® DMP30 you can measure the martensite content reliably and precisely.**

### Importance of the martensite

Already during the manufacturing process of the tanks, martensite with a body-centered tetragonal microstructure is formed from austenite with a face-centered crystalline structure, due to the rapid cooling below the martensite start temperature  $M_S$  (martensite start). The transformation process is terminated by stopping the cooling. By reaching the martensite finish temperature  $M_F$  (martensite finish), the volume fraction of the martensite no longer changes with further cooling.

Also dropping below the  $M_S$  temperature can be problematic. When allowed to cool slowly, the austenite transforms into a mixture of ferrite and cementite. But in a rapid cooling process (i.e. quenching, employed to harden the steel), there is no time for the carbon atoms to diffuse out of the crystalline structure in large enough quantities to form ferrite and cementite, resulting in martensite.



Figure 1: The coarse, acicular crystals of martensite

Too much martensite is undesirable in steel destined for hydrogen tanks, because hydrogen can settle at the grain boundaries of the martensite, such as hydrogen embrittlement or cold cracking, which can then lead to material failures.

Therefore, testing the steel's martensite content with precise measurements is required to determine its suitability for this purpose.

### Specialist for martensite content measurement

Fischer has developed the FERITSCOPE® DMP30 mobile handheld device for these measurement requirements. The FERITSCOPE® DMP30 from the DMP instrument family is ideally suited for the determination of the  $\alpha$ -martensite content. The martensite content is measured as ferrite content in the measuring instrument itself using the magnetic induction method, then converted to martensite content using the factor 1.72 and displayed in martensite %. The factor 1.72 between measured ferrite content and displayed martensite content was determined by Talonen et. al.



Figure 2: FERITSCOPE® DMP30 with probe D-F-Fe for the measurement of martensite

### Up to any challenge

The devices offer numerous functionalities: Highest quality and durability thanks to full aluminum housing with IP64 and scratch-resistant and chemical-resistant display with Gorilla Glass, full measurement control thanks to limit monitoring via light, sound and vibration, a replaceable and quickly rechargeable battery or even the simplest data transfer via USB-C and Bluetooth.

### Flexible measurement and evaluation

The FERITSCOPE® DMP30 can be equipped with probes in specific designs such as axial, angled or for measuring inside center holes. Even in hard-to-reach places, the digital and analog probes provide maximum flexibility and the most precise results. With the intuitive Fischer DataSuite, transferring, evaluating and exporting measurement data is more convenient than ever before.

### Conclusion:

**In order to detect the risks of material fracture due to an excessively high martensite content and to avoid consequential damage, the  $\alpha$ -martensite content in hydrogen tanks can be reliably and precisely determined with the FERITSCOPE® DMP30. The robust and modern design, intuitive operation and its extensive functionalities make the compact handheld device your perfect companion for measuring the martensite content or even the ferrite content in austenitic and duplex steels.**

For more information, please contact our Fischer experts: [sales@helmut-fischer.com](mailto:sales@helmut-fischer.com)