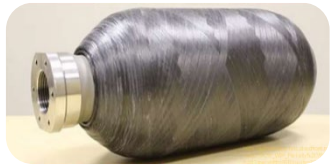
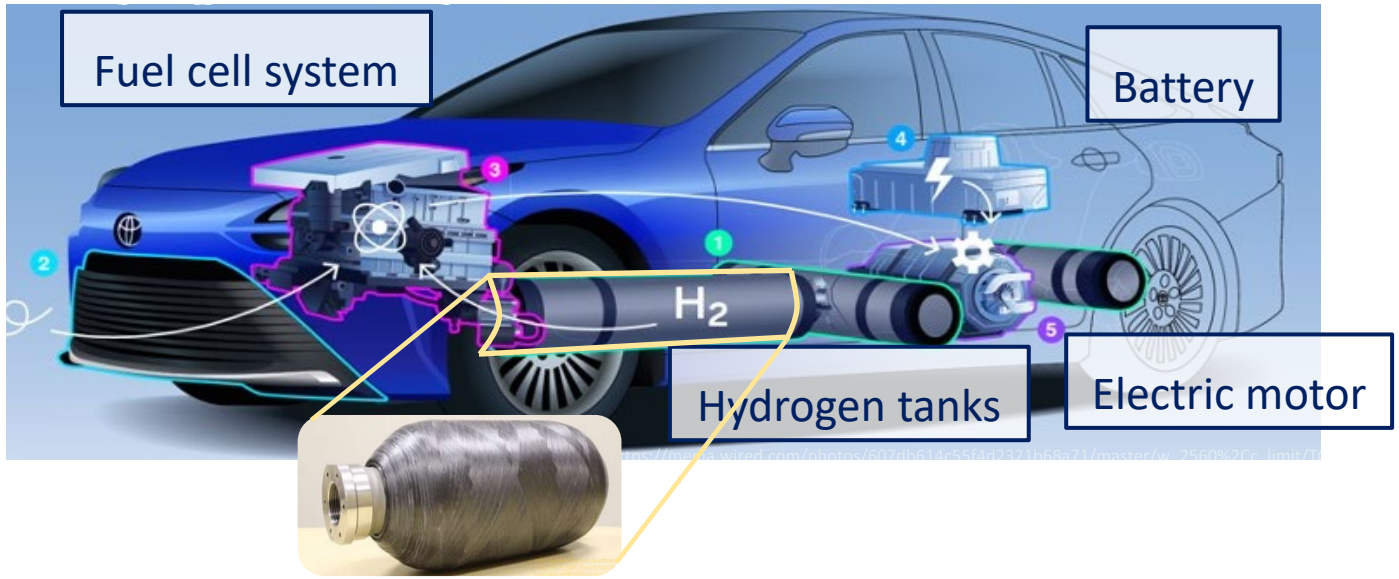
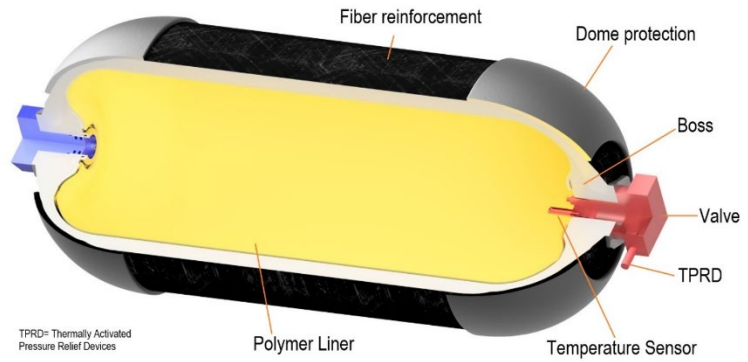
PROJECT: Monitoring of Type IV Pressure vessels for hydrogen storage



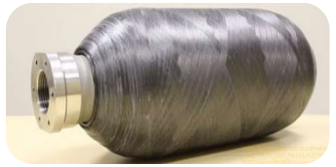
FRAMEWORK:

- Hydrogen-based fuel cells are a trending topic in research and industries due to their high energy efficiency and environmental benefits thanks to their zero-emissions characteristics.
- The high energy density of hydrogen needs stringent storage requirements to prevent leaks and explosions.
- Safe storage and transportation of hydrogen rely on pressure vessels made of composites, such as carbon fibres, which combine excellent mechanical properties with low density, making hydrogen-based fuel cells eligible for several applications.
- Thus, it is extremely useful to monitor pressure vessels to detect sudden damages avoiding hazardous operations.





Collaboration: FABER



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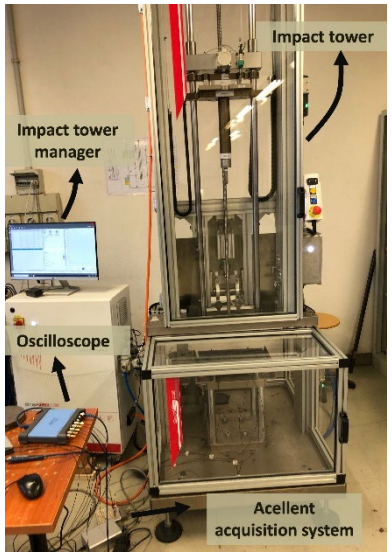
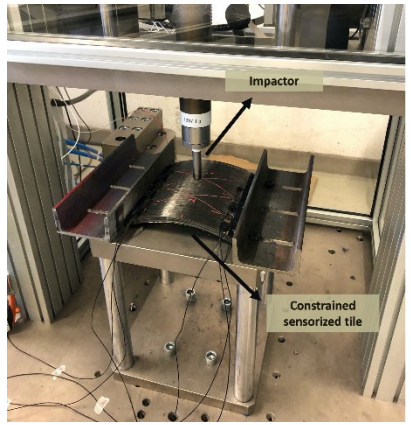
EXPERIMENTAL ACTIVITIES:

- Impact monitoring can be performed with ultrasonic testing (UT) sensors, **fibre optics** and **carbon nanotubes** (CNT).
- Focus on CNTs thanks to their self-diagnosis capabilities since their electric resistance changes when they are loaded. Thus, they can be embedded in the composite pressure vessel matrix for monitoring purposes.
- Two kinds of impact tests are planned:
  - **Low-velocity impact**
  - **quasistatic loading**, to be performed before and after the low-velocity impact to observe changes in the vessel response.





PROJECT: Monitoring of Type IV Pressure vessels for hydrogen storage

TITLE: Fiber-optic sensor based Shape Sensing and Damage Diagnosis of a pressure vessel with iFEM

RESEARCH BACKGROUND: The inverse Finite Element Method (iFEM) is a model-based technique to compute the displacement field of a structure from experimental strain measurements. Nowadays, it can be used also in an SHM framework to perform damage diagnosis. This work aims to perform damage detection (impact damages) and localization on a cylindrical section representative of a composite material pressure vessel.

RESEARCH ACTIVITIES:

1. Implementation of iFEM routines (Matlab and Python) for SHM
2. Development of the iFEM model
3. Experimental tests
4. Data analysis with the iFEM

METHODOLOGY: Numerical, Experimental

DURATION: 9 months

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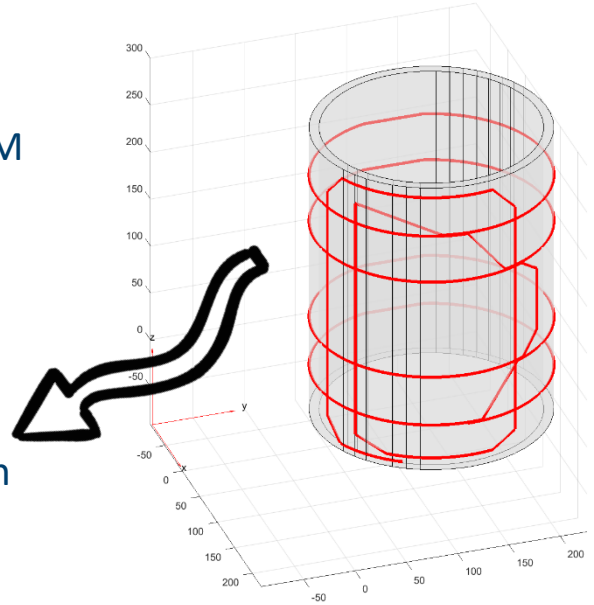
Displacement and strain field reconstruction on the whole structure

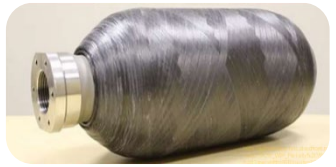
Damage diagnosis (SHM)



Fiber optic pattern with circumferential and axial strain measurements

Section of carbon fiber pressure vessel sensorized with a fiber optic for strain measurement

PROJECT: Monitoring of Type IV Pressure vessels for hydrogen storage

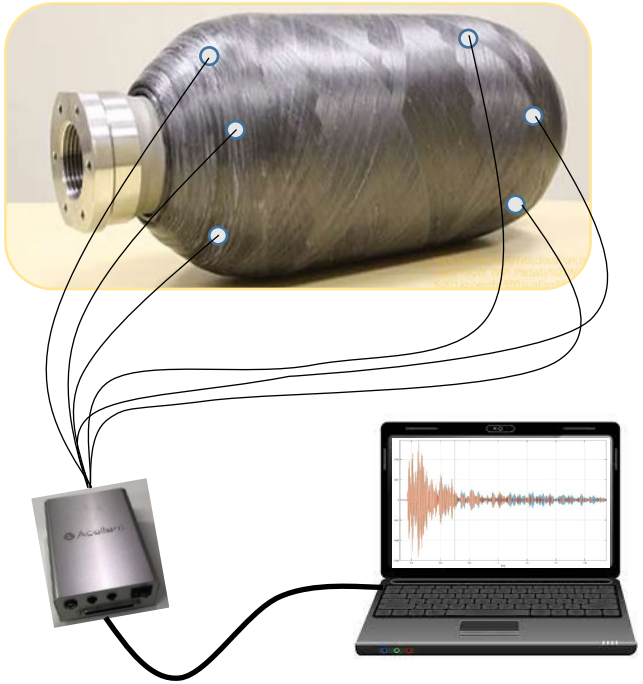


Title: Pressure vessel impact monitoring through carbon nanotubes implementation

RESEARCH BACKGROUND:
Hydrogen is a promising fuel but it requires safe storage to prevent accidents like explosions, therefore composite pressure vessels are used for its storage and transportation. However, vessels can be damaged and early detection of damages is fundamental for low-risk operations. For this reason, carbon nanotubes are embedded in the composite matrix for monitoring purposes and experimental tests are going to be carried out, allowing damage diagnosis.

RESEARCH ACTIVITIES:

- Experimental impact tests on carbon fibre type IV pressure vessel
- Implementation of algorithms (Matlab/Python) to perform damage detection/diagnosis



METHODOLOGY: numerical - analytical - experimental

DURATION: 9 months

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