GRMH2TANK: High-performance and lightweight Graphene-CFRP compressed Hydrogen storage tank for aerospace applications

Main area: Functional coatings
Keywords: Hydrogen storage;Graphene impermeability; GRM reinforcement, GRM enhanced matrix CFRP; nanomaterial enhanced 3D printed liner;
Duration (months): 24
Total project funding: € 1 280 848

Abstract

Compressed fuel for aerospace applications is since long seen as an outstanding durable and damage tolerant (D&DT), and reliable candidate for an environmentally sustainable future. Since the first studies, the design of light yet highly insulated tanks for pressurized hydrogen has been identified as one of the key enabling technologies.
This proposal details the plans of this consortium to design and develop a Graphene based high-performance and lightweight compressed hydrogen storage tank demonstrator for aerospace applications. The tank will be composed of:
a) Nanomaterial reinforced Fused Deposition Modelled (FDM, 3D printing) polymer liner,
b) Graphene low permeability layer and
c) Graphene and Related Materials reinforced matrix CFRP composite overwrapped layer.
The demonstrator will satisfy a TRL level 3.
The proposed tank exploits the material properties of GRMs like impermeability, structural strength and electrical conductivity, to develop a product with the following features:
1. High strength and Low weight
2. Low-permeability
3. High Durability and Damage Tolerance (D&DT) under static burst, fatigue, autofrettage, and impact loading conditions
4. High Reliability considering scatter in manufacturing processes, material, geometrical shape
5. High electrical conductivity for lightning protection
6. Stability in extreme conditions (e.g. aeronautical environment with an ambient temperature variation from +55 °C to -55 °C, and an ambient pressure variation from atmospheric to 0.3 bar, and around 10,000 such take-off to landing cycles over five years).
This proposed project undergoes the following evolution of design:
- Nanomaterial candidate selection and analysis
- Sample development for individual functional components – liner, membrane and overwrap.
- Development of numerical models for three functional components
- Experimental analysis of samples via permeability testing, mechanical and electrical testing
- Numerical model validation with experimental results
- Design and numerical analysis of combined tank demonstrator system
- Safety analysis of tank system
- Manufacturing of tank demonstrator prototypes
- Experimental analysis including leakage tests (using low pressure Hydrogen) as well as mechanical and electrical tests, and verification
- Certification programme and business plan

This project adopts a system integration approach: The engineering and fabrication process will be performed hand in hand and iteratively with safety analyses and certification study to ensure ease of induction of the final product into the aerospace market.

Consortium

Rainer Adelung - Kiel University - Germany - Funded by: DFG - (Coordinator)
Matthias Ziegenhorn - Brandenburgische Technische Universität Cottbus Senftenberg - Germany - Funded by: DFG
André Luz - GLEXYZ - Portugal - Funded by: FCT
Udo Wagenknecht - Leibniz-Institut für Polymerforschung Dresden e.V - Germany - Funded by: DFG
Cédric Huchette - Office National d'Etudes et de Recherches Aérospatiales - France - Funded by: ANR