RINA

“ MATERIALI E INNOVAZIONE: UNA NUOVA SFIDA

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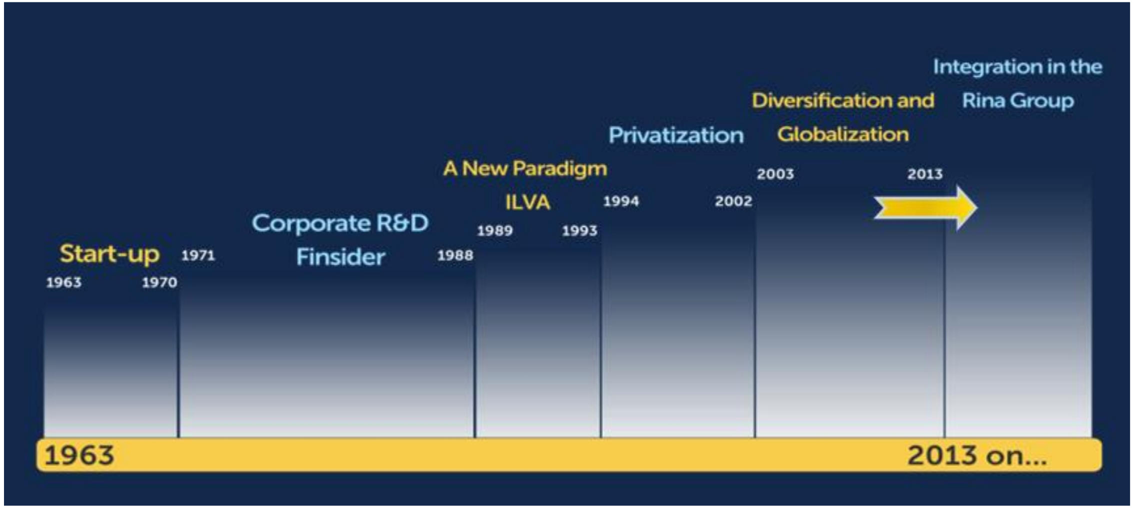
RINA-CSM Headquarter Castel Romano - Rome

RINA - Centro Sviluppo Materiali

RINA-CSM was founded in 1963 by Italy's major steel manufacturers and end-users with the mission of developing steel technologies and applications.

It is a fully private innovation centre with extensive experiences for the development and application of innovative processes and materials. Since 2014 RINA - CSM is 100% part of RINA.

The industrial sectors of main interest to the RINA-CSM are Energy and Environment, Iron and steel, Oil and gas, Aerospace, Defense, Mechanics and transport.



RINA - CSM at a glance

- More than 200 people full time devoted to R&D; 75% degree
- 22-25 MEuro annual turnover, 80 % coming from industrial projects
- More than 25 labs and pilot plants
- 10% of revenues are re-invested in internal R&D projects and equipement

- Headquarters in **Rome**
- Terni Unit **inside Acciai Speciali Terni:** Stainless Steel and Electrical Steel
- Dalmine Unit, **inside TENARIS:** Seamless pipe and Combustion testing
- Lamezia Terme unit: **Renewables**
- Napoli Unit: **Smart Factory Solutions**
- Perdasdefogu site: **Full scale tests** (burst tests, bending…….)

RINA today

4,000
colleagues

200
offices

70
countries

Our people

More than **90 nationalities**

70%+
educated to degree level

43
average age

MATERIALS AND INNOVATION: A NEW CHALLENGE

MATERIALS FOR:

- Hydrogen (transport, storage and distribution: qualification, standardization and certification)
- Additive Manufacturing (mechanical and efficient applications)
- Low wettability coatings (photovoltaic panels)
- Decarbonization
- Safe By Design and Sustainable by Design Concepts

Hydrogen: Strengths and Use

- Carbon Free
- Energy Vector
- Versatility
- Storability

H_2 for Grid Balance

Solutions for **innovative utilities and sector coupling**

- Power-to-X
- Island H_2

H_2 for Transport

Solutions for **Mobility**

- H_2 for Marine
- H_2 for Rail & Truck
- H_2 for Urban transport
- H_2 for Material Handling

H_2 for commercial use

Fuel Cells for **business continuity and heating**

- H_2 for Power Supply
- H_2 per residential and commercial heating

H_2 for Industrial use

Green transition in **Industrial Processes**

- H_2 for Feedstock
- H_2 for High Temperature processes

Challenges in Hydrogen Storage as gas or liquid

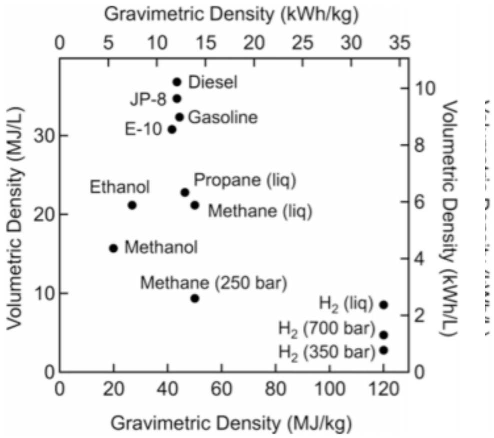
As a gas	As a pressurised gas	In a liquid form
0.0852 kg/m3 at atmospheric pressure	42 kg/m3 of H2 at 700 bars	70.5 kg/m3 at -253°C at atmospheric pressure

Gaseous H_2 Storage (VERY HIGH PRESSURE):

The volumetric density of storage could be increased by further **increasing the pressure of H_2** in tank. However, the thickness of the walls (and therefore the mass) of the tank is related to P that the same must endure and increases with this.

Liquid H_2 Storage (VERY LOW TEMPERATURE):

Liquid hydrogen storage systems show good volumetric storage efficiencies; however, special handling requirements, long-term storage losses from liquid boil-off, and **cryogenic liquefaction** energy requirements are penalties against their applicability.



Materials for Hydrogen storage

Which material for a high-performance hydrogen tank?

Material chosen for hydrogen tank must absolutely comply with these criteria:

- Damage, fatigue, ageing,
- Chemical compatibility,
- Resistance, stiffness, fragility,
- Thermal expansion, permeability

Possible materials for cryogenic applications

- Steels (too heavy)
- Titanium alloys (too expensive)
- Carbon fiber composite (non-recyclable, expensive but very light)
- Aluminium (resistant and less expensive but heavier than composite)

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Low pressure Storage

Strategies to increase H_2 density

H_2 has high gravimetric energy density and **very low volumetric density**

Liquefaction

70 Kg/m³

40% energy cost

Liquid at 20 K

Compression

40 Kg/m³

13% Energy cost

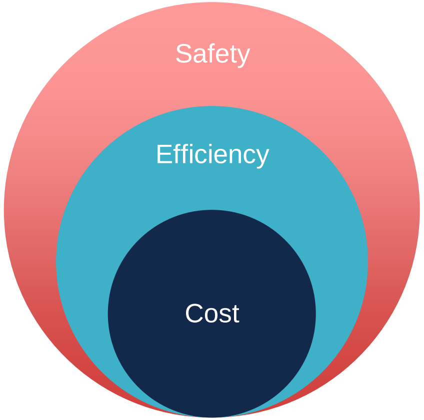
Compressed at 700 bar

Ab/Adsorption

≈70 Kg/m³

<1% Energy cost

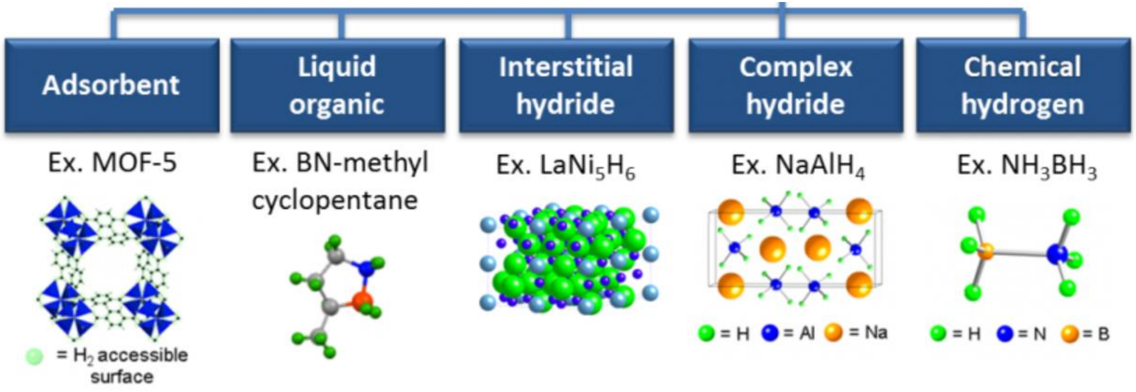
Adsorbed at 30 bar



Challenges in Hydrogen Storage as a solid

Solid H2 Storage:

- Recent interests have been shifted toward solid-state hydrogen storage systems
- Light metals of groups 1, 2, 3, for example Li, Mg, B and Al give rise to a great variety of metal-hydrogen complexes (Hydrides)

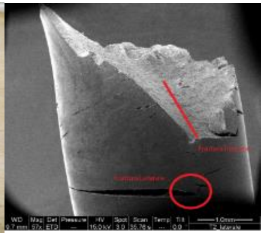


Material Performances
Hydrogen ΔH Laboratory

Material performances for hydrogen transport - Asset integrity

Nowadays investment bank (EIB) are funding **ONLY** project for requalification and new project for green economy – i.e. Hydrogen Ready gas Pipeline.

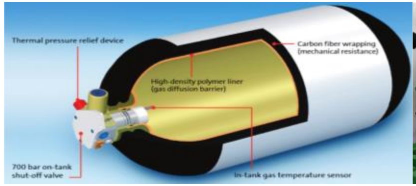
Test on materials
SMALL SCALE unit
Fatigue, Fracture Mechanics, SSR



H_2 test pressure up to 1000 bar
Hydrogen Piping & Pipelines

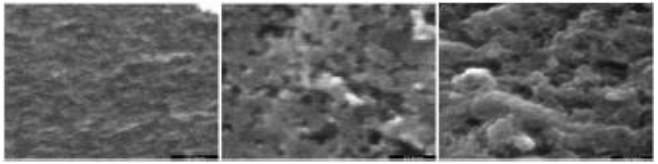
US standards (ASME B31.12, ASME BPVC, ASTM E1681) and the European guideline (EIGA, IGC Doc 121/14)

Test on components
Full Scale



H_2 test pressure
100÷1000 bar
Test on coponent

Test on nano-materials
HPCT unit



H_2 test pressure
0÷300 bar
Test on adsorption

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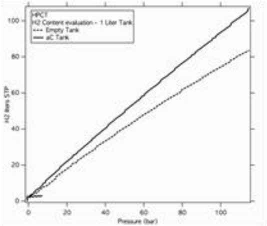
Low pressure Storage

High Pressure Concentrate Temperature - testing unit

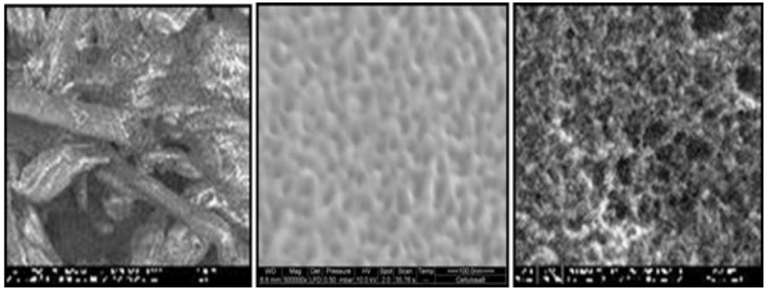
Different types of materials (**activated carbon, zeolites, polymer, MOF, metal hydrides**) can increase the storage capacity of a tank. In this unit, the (nano-)materials are inserted into a cylinder to test their storage capacity at pressure up to **200 bar** and in a wide temperature range.

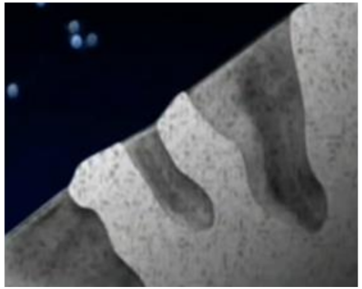
Applicable test conditions up 40 liter bottles and 15kg of microporous materials	
Pressure	1 ÷ 200 bar
Temperature range	-20 ÷ 100 °C
Flow Rate	2 ÷ 100 Nl / min



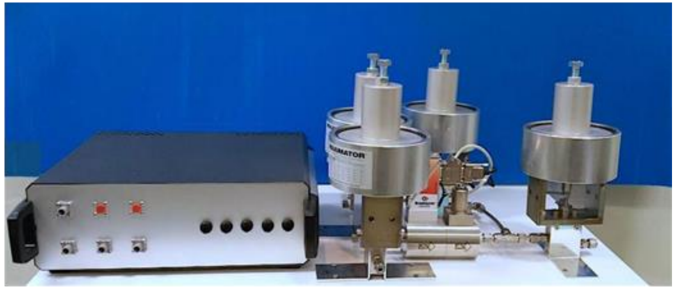
The measurement of the H_2 storage capacity is achieved in combination with input/output flow dynamical behavior (100 litres).

SEM micrographs of nano-materials





HPCT system



NANOMATERIALS SAFE AND SUSTAINABLE BY DESIGN

Call identifier:
NMBP-16-2020 - Safe by design, from science to regulation: multi-component nanomaterials

Type of action:
Research and Innovation action

Starting date:
01/05/2021

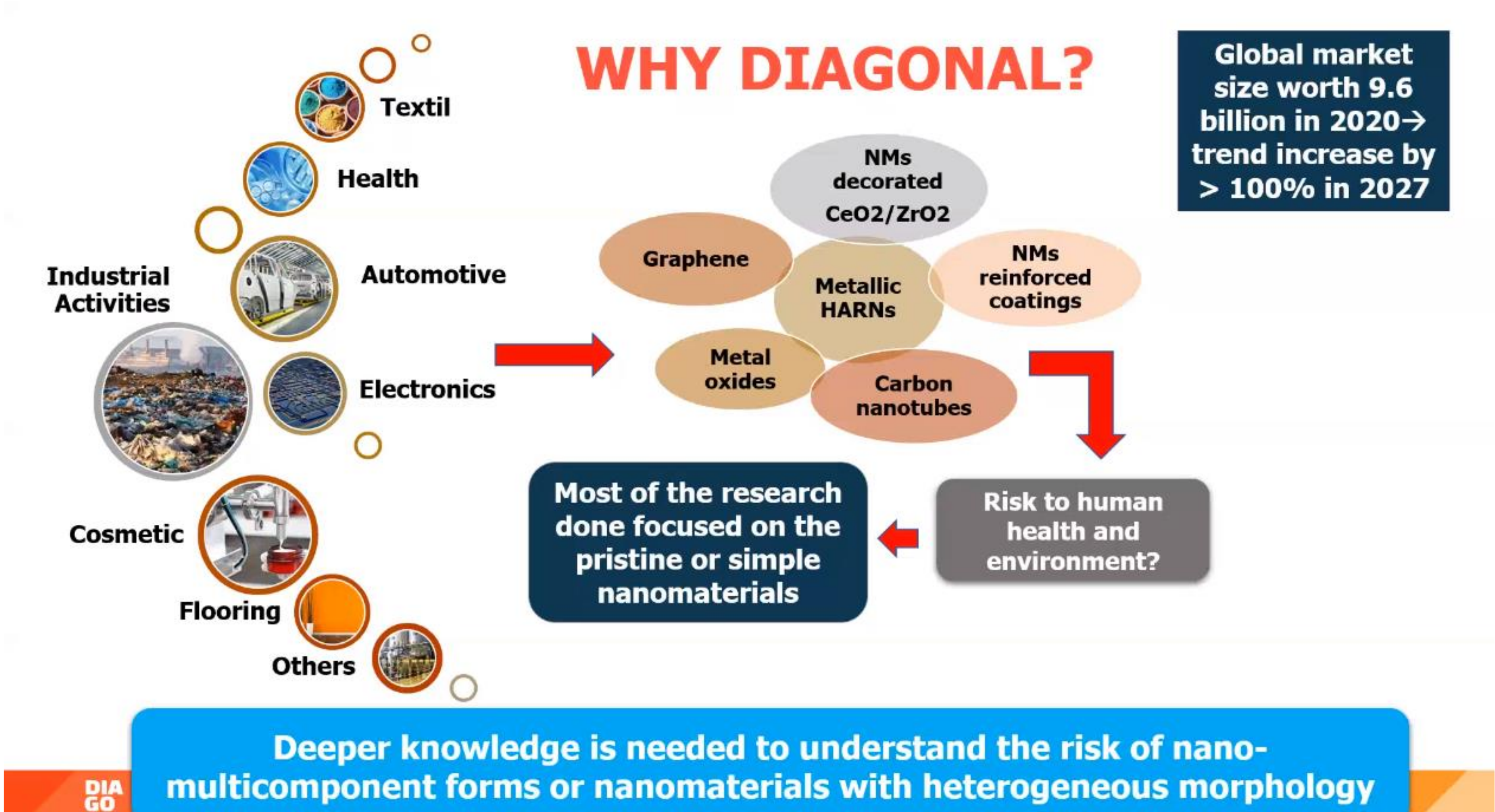
Duration in months: 42
(31/10/2024)

PROJECT OVERVIEW

DIAGONAL

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 953152

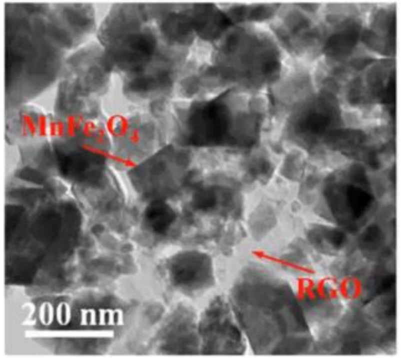
NANOMATERIALS SAFE AND SUSTAINABLE BY DESIGN

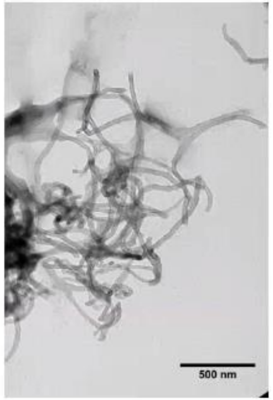


NANOMATERIALS SAFE AND SUSTAINABLE BY DESIGN

DIAGONAL PROJECT

Aims to address **existing research gaps** **(at RA, RM and RG levels)** in the understanding of **Multi-Component NanoMaterials (MCNMs)** **and** **High Aspect Ratio Nanoparticles (HARNs)** **constituents' interactions (among components and with the environment), release and fate and their influence on the NMs toxicity**





Risk management and governance

Safe-by-Design strategies

- Design, produce and use substances with lower hazardous characteristics while maintaining their functionality
- Reduce exposure of workers, consumers and the environment

Tree pillars underpinning Safe by Design:
Safe products
Safe production
Safe use

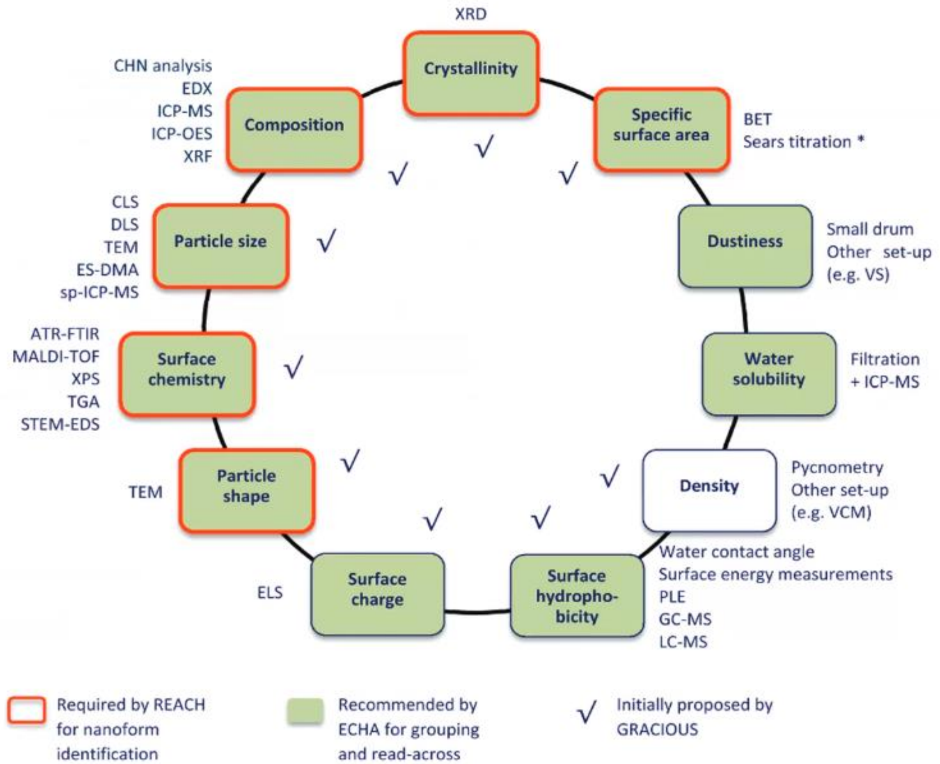
Life cycle sustainability concept integration: towards a SusbD approach

- To understand the overall impacts of SbD strategies and how they could be improved → life cycle sustainability indicators to support decision makers

Electrification

Risk assessment

Physicochemical analysis



RINA

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Make it sure, make it simple.