

# Present and Future Opportunities for Nanotechnology in the Space Sector: ASI perspectives and initiatives

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- ① **Benefits of Nanotechnology in Space Missions**
- ② **Challenges and Possible Developments**
- ③ **National Opportunities**
- ④ **Summary**

# Space Technology Pillars in ASI

## ✓ Strengthening Competencies

National Flagship Missions aimed to maintain a leading role in science and applications, based on the national excellences built on longtime investments and efforts: optical and radar sensors, deep space habitat, Telecommunication and deep space, planetary exploration

## ✓ Developing new technologies

In order to meet a combination of mission pull (requirements and emerging applications) and technology push (e.g. disruptive, innovative) approaches, the space sector need a continuum innovation, new investments are necessary in low TRL Technologies and new system architecture enabling innovative space missions

## ✓ Cooperation and Competition

Actively participation in the strategic roadmap definition and monitoring at european level in order to ensure the support of italian competences and the capitalization of national investments

# Space Challenges

- ◎ **Technical Budgets (e.g. Mass/Power)**
  - ✓ Reduced fuel consumption & emissions
  - ✓ Reduced launch costs
  - ✓ Enabler for many vehicles and missions profiles
  - ✓ Reduced power consumption
- ◎ **Dependability and Environment**
  - ✓ Maintenance down-time and costs
  - ✓ Reliability over long period of time
  - ✓ Extreme environments Radiation Hardening/Vibrations
- ◎ **Functionality/Performance**
  - ✓ Multifunctionality
  - ✓ Architectural Flexibility (multi-mission/multi-target)
  - ✓ From discrete architectures to continuous structures

## Is Nanotechnology the solution?

# Benefits of Nanotechnology in Space Missions

- ◎ Nanotechnology has the capability to radically change the way to perform missions in space reducing weight, improving functionalities and increasing durability, producing benefits in the following areas:
  - ✓ **Mechanical** (acting on morphology and strength of interfaces, molecularly perfect, highly ordered, defect free structures, ....)
  - ✓ **Thermal** (having an effect on emissivity, influenced by particle size and enhanced surface area/roughness, conductivity, controlled by particle size)
  - ✓ **Electrical** (acting on nano structure and defects influence conductivity and bandgap energy - conductivity, current density, thermoelectric effects -, nanoscale dimensions lead to inherent radiation resistance)
  - ✓ **Optical** (Transparency and color dominated by size effects, Photonic bandgap controlled by size and nanostructure).

# Nanotechnologies In Space

- ◎ Areas where nanotechnologies have the greatest potential to impact components and sub-systems:
  - ✓ engineered materials and structures (self healing and multifunctional materials),
  - ✓ power generation, energy storage and power distribution (energy harvesting, nanomachines for energy conversion and storage)
  - ✓ propulsion and propellants (high performance and low environmental impact)
  - ✓ sensors, electronics, and devices
  - ✓ life support systems (sensors for biological and environmental monitoring)
  
- ◎ Nanotechnologies will impact state of the art technical solutions and transform the design paradigms used in spacecraft conception
  - ✓ e.g. new concept for Clean Space/Debris mitigation

# Opportunities in on-going activities

## ◎ **Short – Medium term enhancement (3 to 5 years)**

PLATiNO: A new Small Satellites platform development

- Goal: to identify and support the development of new subsystems/unit/component technologies in order to enable a real breakthrough for innovative architectures
- Mini-satellite class capability with high performance and able to support a wide spectrum of missions

## ◎ **Long term enhancement (> 5 years)**

Low TRL public Invitation To Tender

- Goal: to identify and develop early stage innovative technologies and concept in order to enable future competitive products
- Technologies that enable a game change in system design approach
- Validation of potential through system studies in the Concurrent Engineering Facility

# Summary

- ⊙ A global effort to enhance capabilities and affordability of space missions is ongoing in every application field
- ⊙ Nanotechnology has the capacity to radically improve the way to perform space missions, including:
  - ✓ Reduced weight
  - ✓ Improved functionality
  - ✓ Increased durability
- ⊙ Challenges and capabilities, addressed by nanotechnology, are being supported by ASI through various national initiatives
- ⊙ Main developments will be carried out in the frame of national program PLATiNO and dedicated call for proposal





**Thank You**