

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

R. Formaro - G. Varacalli, ASI

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- Benefits of Nanotechnology in Space Missions
- Challenges and Possible Developments
- National Opportunities
- Summary



✓ Strenghtening Competencies

National Flagship Missions aimed to mantain 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, Telecomunnication 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

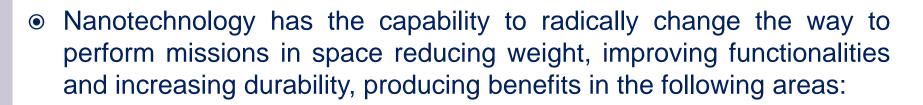
- Maintenance down-time and costs
- ✓ Reliability over long period of time
- ✓ Extreme environments Radiation Hardening/Vibrations

• Functionality/Performance

- ✓ Multifunctionality
- ✓ Architectural Flexibility (multi-mission/multi-target)
- ✓ From discrete architectures to continuous structures

Is Nanotechnology the solution?

Benefits of Nanotechnolgy in Space Missions



- ✓ 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)
 - \checkmark 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





- 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