Impact of Nanotechnology in Materials on Aviation

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Problem

As nanotechnology innovations begin to enhance aircraft characteristics, how will this impact aviation and the performance of the National Airspace System (NAS)?

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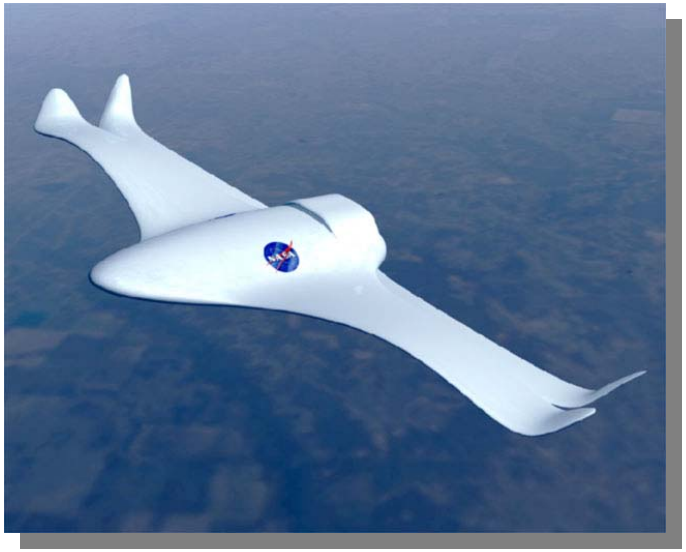
Background

- Advances in computation, sensing, and aircraft materials carried by innovations in nanotechnology
- *Problems:*
  - **Fabrication & Cost**
    Massive, parallel production of nano-systems evolving
  - **Conceptualization**
    Nontraditional aircraft designs
  - **Integration**
    Air traffic control adaptation to robust flight profiles



NASA Langley Morphing Wing Concept Vehicle
http://oea.larc.nasa.gov/PAIS/21stcentury.html

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Objectives

- Investigate and identify new aircraft performance characteristics resulting from nanotech advances, esp. wake vortex mitigation via stronger, lighter carbon nanotube reinforced polymer (CNRP) composite airframes
- Characterize possible effects of nanotechnology on aviation as they propagate through the NAS

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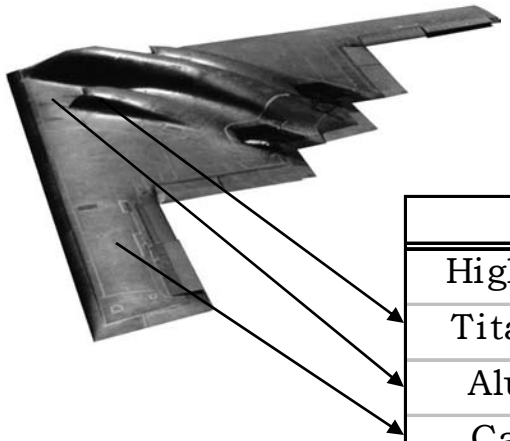
Activities

- Quantifying impact of notional CNRP composite airframes on wake vortex mitigation and the resultant potential safe reduction of aircraft spacing
- Investigating smart materials, molecular electronics, nanosensors, and other novel molecular devices
- Exploring application concepts to improve the safety and efficiency of flight

Highlight



Looking beyond current advanced aircraft materials such as those used in the B-2 Stealth Bomber…

Material	Density (g/cc)	Modulus (Gpa)	Strength (Mpa)
High Carbon Steel	7.6	207	676
Titanium (Ti-55A)	4.5	83	241
Aluminum 2024	2.8	70	468
Carbon Fiber RP	2.7	140	2505
Carbon Nanotube RP	**1.2**	**147**	**15220**

…To Carbon Nanotube Reinforced Polymer (CNRP) composites for airframes

- ***50% lighter and 6x stronger*** **than current carbon fiber composites**
- **A few possible effects on aircraft performance include reduction of wake vortex circulation, takeoff velocity, and braking times**

Carbon Nanotube
Image via Scanning Electron Microscope

Chart Values from Machinery's Handbook, 25th ed., except Carbon Nanotube (CNT) RP
Right: www.ipt.arc.nasa.gov/finnfigures.html
Left: www.afit.edu/gallery/Clipart/aircraft/B-2-1l.JPG

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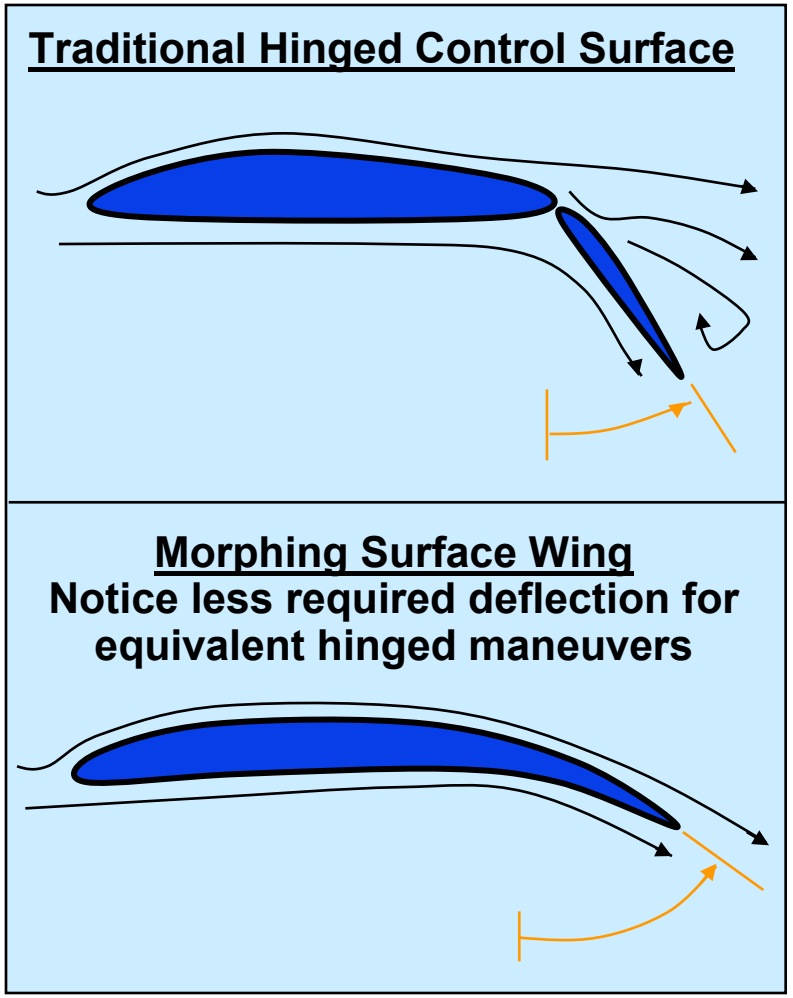
Highlight

- Embedded actuation
  - Enhanced displacement potential of morphing materials
  - Potentially improve aerodynamic efficiency
- Localized sensing
  - Enables continuous airframe health monitoring
  - Possibly increases airport productivity with lower aircraft maintenance time



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Impacts

- MITRE concepts on future vision of aviation incorporated in RTCA NAS ConOps
- Brainstorming on future aircraft spurred alternative air traffic concepts currently under collaborative investigation with other MSRs

- Continued involvement in MITRE's world-renowned student nanotechnology R&D

Future Plans