Fast Response Shape Memory Effect Titanium Nickel (TiNi) Foam Torque Tubes

High-speed, high-torque torsional actuators for aerospace applications

Shape Change Technologies has developed a process to manufacture net-shaped TiNi foam torque tubes that demonstrate the shape memory effect. The torque tubes dramatically reduce response time by a factor of 10. This Phase II project matured the actuator technology by rigorously characterizing the process to optimize the quality of the TiNi and developing a set of metrics to provide ISO 9002 quality assurance. A laboratory virtual instrument engineering workbench (LabVIEW™)-based, real-time control of the torsional actuators was developed. These actuators were developed with The Boeing Company for aerospace applications.

Applications

NASA
- “Morphing” unmanned aerial vehicles (UAVs)
- Concept vehicles:
  - Using wing twist to control flexible wing structures
- Deployment of booms:
  - Deploying sensors in aircraft and/or in spacecraft where the lightweight, minimal part count actuators could be heated electrically
- Next-generation shuttles (actuators must also be space qualified):
  - Controlling wing twist, nacelle structures, or ancillary aircraft structures

Commercial
- Aviation:
  - Controlling variable nacelle structures
- Windmills and turbines:
  - Generating energy more efficiently
- Health care:
  - Assisting the disabled as a lift device (similar to hydraulic actuators but with less bulk)

Phase II Objectives
- With Boeing:
  - Optimize materials to reduce contamination
  - Develop ISO 9002 production standards
  - Develop high-speed, high-torque torsional actuators
- Fully characterize the materials mechanically and chemically during production to minimize oxide/hydride contamination
- Develop LabVIEW-based computer-controlled actuation for on-off and proportional control
- Develop infrastructure to support batch production of actuators
- Test actuators (Boeing provides in its testbed facility)

Benefits
- Large torque
- Fast response
- More aerodynamically efficient structures

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