National Aeronautics and Space Administration

NASA Langley's

Active Flow Effectors for Noise and Separation Control

Variable effectors for enhanced vehicle and aeroelastic control

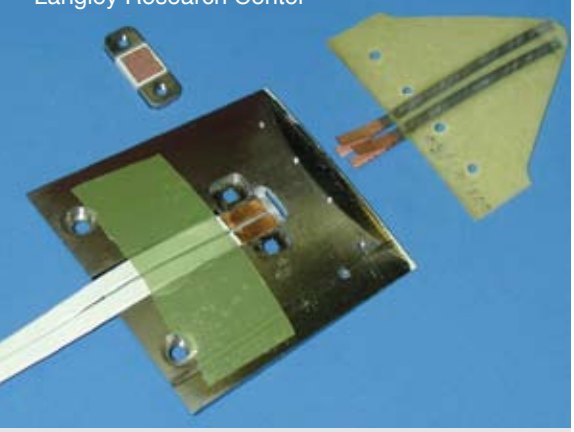
NASA Langley has created novel flow effector technology for separation control and enhanced mixing. The technology allows for variable shape control of aircraft structure through actively deformable surfaces. The flow effectors are made by embedding shape memory alloy actuator material in a composite structure. When thermally actuated, the flow effector deflects into or out of the flow in a prescribed manner to enhance mixing or induce separation for a variety of applications, including aeroacoustic noise reduction, drag reduction, and flight control. NASA developed the active flow effectors for noise reduction as an alternative to fixed-configuration effectors, such as static chevrons, that cannot be optimized for airframe installation effects or variable operating conditions and cannot be retracted for off-design or fail-safe conditions.

Benefits

- Increased vehicle control, overall efficiency, and reduced noise throughout all flight regimes
- Reduced flow noise
- Reduced drag
- Simplicity of design and fabrication, highly repeatable
- Simplicity of control through:
  - direct current stimulation
  - autonomous response to environmental heating
  - fast response
  - high degree of geometric stability

partnership opportunity

Langley Research Center



Flow effector components include a chevron with embedded SMA actuators

The Technology

NASA has developed a novel approach for active jet nozzle flow effectors, or chevrons, based upon shape memory alloy hybrid composite (SMAHC) technology. The concept involves embedding pre-strained SMA actuators on one side of the chevron neutral axis in order to generate a thermal moment and deflect the structure out of plane when heated. The force developed in the host structure during deflection and the aerodynamic load are used for returning the structure to the retracted position.

The NASA chevron design is highly scalable and versatile, and easily affords active and/or autonomous (environmental) control.

Prototype chevrons at 1:9 scale have been built and tested, including thermal cycling tests, repeatability tests, and tests with representative flow conditions at NASA Langley. All aspects of the chevron performance were found to be very repeatable, including closed-loop performance of the chevron tip to prescribed positions while immersing into and retracting from the flow.

Chevron flow effectors are part of this engine nozzle chevron design that uses asymmetrical scallops around the engine to reduce noise. Image credit: The Boeing Company/Bob Ferguson

Applications

The technology offers wide-ranging market applications, including:

- Aerospace – actively deformable surfaces (chevron, e.g.) with closed loop control for:
  - distributed spoilers
  - jet noise control
  - airframe noise control
  - flow separation control over high lift devices
- Defense weapons bay
  - adjustable flow to reduce damaging noise during opening
  - reduced thermal footprint due to flow when opening bay
- Automotive – flow control for aerodynamic flow optimization

For More Information

If your company is interested in licensing or joint development opportunities associated with this technology, or if you would like additional information on partnering with NASA, please contact:

The Technology Gateway

National Aeronautics and Space Administration

Langley Research Center
Mail Stop 218
Hampton, VA 23681
757.864.1178
LARC-DL-technologygateway@mail.nasa.gov
technologygateway.nasa.gov

www.nasa.gov

LAR-17332-1

Vol 1, Issue 3
NP-2008-04-77-LaRC