Switchable Stiffness
Morphing Aerostructures
using Granular Jamming

David Brigido
Stephen Burrow
Benjamin Woods

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From rigid to compliant

Rigid wing

Flexible wing

Conventional Mechanism

Turbulent Flow

Higher noise and drag

Rigid control surfaces

Compliant control surfaces

Switchable-Stiffness
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From rigid to compliant

Rigid wing

Conventional Mechanism

Turbulent Flow

Higher noise and drag

Rigid control surfaces

VS

Flexible wing

non-discontinuities (smooth transition)

Lower noise and drag

Compliant control surfaces

Switchable-Stiffness
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Fish Bone Active Camber (FishBAC)

[1] Video: B. Woods, University of Bristol

Inspired by Nature

Fish skeleton
Flexible wing of the bird

FishBAC Mechanism

Granular Jamming

- Solid-like: More contact among particles.
- Liquid-like: Less contact among particles.

\[ \phi = \frac{N_p V_p}{V_S} \]

Switchable Stiffness FishBAC

Inspired by Nature

Fish skeleton
Flexible wing of the bird

FishBAC Mechanism

Elastic Membrane
Granular media
Lower noise and drag

Compliant control surface
Switchable-Stiffness FishBAC

Elastic Membrane
Granular media

Jamming by Vacuum

Variable Stiffness

Switchable Stiffness FishBAC (SwitchBAC)

Morphing Wing

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Switchable Stiffness FishBAC

Inspired by Nature
- Fish skeleton
- Flexible wing of the bird

FishBAC Mechanism

Elastic Membrane  Granular media
Lower noise and drag

Compliant control surface
Switchable-Stiffness FishBAC

Switchable Stiffness FishBAC (SwitchBAC)

Morphing Wing

Variable Stiffness

Elastic Membrane  Granular media

Jamming by Vacuum

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Flexural properties

Vacuum at 0.85 bar.

Vacuum at 0.5 bar.

- Four-point Bending tests.
- Test frame machine.
- Video gauge system.

Digital image correlation:
- Full-field displacement.
- Full-field strains.

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SwitchBAC

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Questions?

David.Brigido@bristol.ac.uk

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