

3D WINGS OR BLADES WITH AIRFOIL-SHAPED MINIATURE WING ATTACHMENT

IITM Technology Available for Licensing

Problem Statement

- ❑ Flow separation on aerodynamic surfaces **causes loss of lift, increased drag, and reduced efficiency** in wings, turbine blades, and rotors, negatively **impacting performance and stability**.
- ❑ Traditional vortex generators (VGs) like rectangular or triangular plates **delay flow separation but introduce drag penalties** and have limited effectiveness at high angles of attack.
- ❑ **Aerodynamically contoured VGs** reduce drag somewhat, but **still struggle with lift loss, laminar separation bubbles, and stall control**, especially at post-stall conditions.
- ❑ There is a need for a **new blade design that improves stall angle, reduces flow separation and laminar separation bubbles, enhances lift, and minimizes drag** achieved by attaching Clark-Y shaped miniature **airfoil wings on 3D blades to extend operational efficiency and range**.

Intellectual Property

- IITM IDF Ref 3298
- IN Patent 202541052522 Application No

TRL (Technology Readiness Level)

TRL 4, Technology Validated in Lab

Technology Category/ Market

Category- Aerospace & Defense Technologies Industry:

Wind Energy Industry, Aerospace Industry, Automotive Industry

Applications:

Aircraft Wings, Wind Turbine Blades, Tidal Turbine Blades, Gas Turbine Blades, Fans, Helicopter Blades.

Market report: The 3D Printing In Aerospace And Defense Market size is estimated at **USD 3.41 billion in 2025**, and is expected to **reach USD 8.00 billion by 2030**, at a **CAGR of 18.57%**.

Research Lab

Prof. RINKU MUKHERJEE

Dept.of Applied Mechanics & Biomedical Engineering

3D Wing / Blade

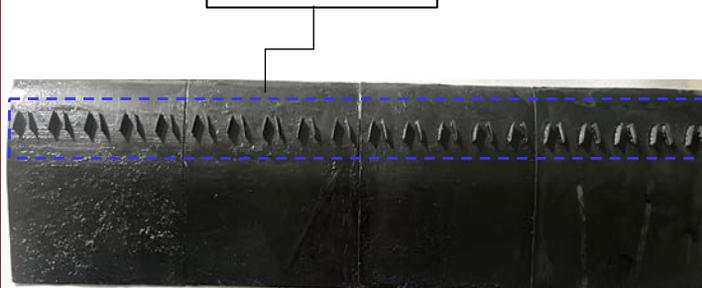


Figure 1: illustrates 3D printed blade model with airfoil-shaped miniature wings shows the overall design and integration of MWs on the blade surface.

Air foil shaped miniature wings

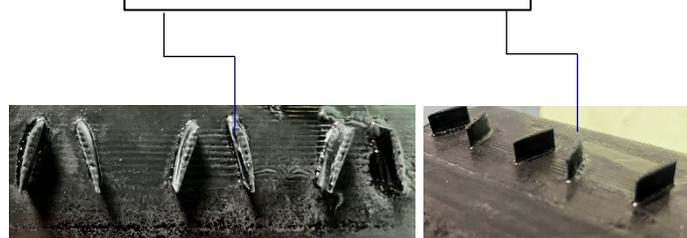


Figure 2: illustrates Close-up of airfoil shaped miniature wings on the blade surface highlights pair arrangement and spacing.

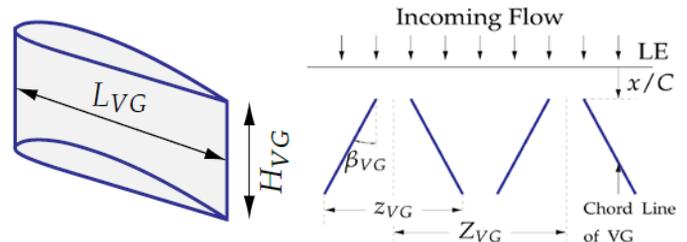


Figure 3: illustrates precise dimension, inclination and placements of the miniature wings.

CONTACT US

Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

Email: headtto-icsr@icsrpis.iitm.ac.in
ttooffice@icsrpis.iitm.ac.in

Phone: +91-44-2257 9756/ 9843

Technology

1 The 3D wing or blade features **multiple airfoil-shaped** miniature wings mounted on its surface in one or more rows, **enhancing aerodynamic performance.**

2 These miniature wings specifically have a **Clark-Y airfoil profile**, known for its effective aerodynamic characteristics.

3 The height of the miniature wings is **about 5%** of the main wing or blade chord. They come **with aspect ratios chosen from 1.2, 2.4, 3.6, and 4.78** to optimize flow control and lift.

4 The miniature wings are **arranged in pairs** to create beneficial aerodynamic effects, such as generating **strong counter-rotating vortices to energize the boundary layer.**

5 The miniature wings can either be glued onto the **blade or 3D printed** along with it. The technology is applicable **to various wind apparatuses**, including windmills, turbines, aircraft wings, and fans.

Key Features / Value Proposition

1 **Enhanced Stall Angle :** MWs increase the **stall angle from 11° to 13°** and sustain a higher lift coefficient over a wider range (0°–20°) compared to clean blades.

2 **Drag Reduction :** Miniature wings equipped blades **reduce drag by 27.68%**, while conventional rectangular and triangular vortex generator **increase drag by 45.27% and 66.65%, respectively.**

3 **Miniature Wing:** Clark-Y shaped miniature wings **with 5% chord height and 10% chord length** are arranged in **counter-rotating pairs at ±18° inclination** with optimized spacing for **effective vortex generation.**

4 **Vorticity and Flow Control:** Miniature wings generate **200% stronger peak vorticity than rectangular VGs**, effectively energizing the boundary layer, suppressing laminar **separation bubbles**, and **maintaining flow attachment post-stall.**

5 **Lift Enhancement with Medium Aspect Ratio Blades:** Medium AR blades (2.4 and 3.6) with MWs achieve lift nearly equal to that of high AR blades, enabling lighter, **cost-effective designs without efficiency loss.**

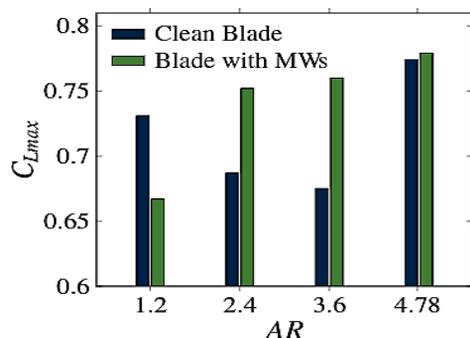
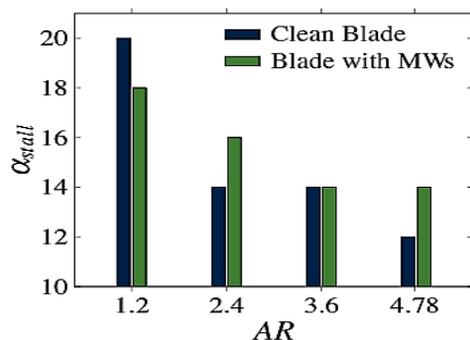


Figure 4: illustrates Comparison of C_{Lmax} and stall angle (α_{stall}) for blades with and without miniature wings (MWs), showing enhanced lift and delayed stall for MW-equipped blades across different aspect ratios.

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