LEAF Technology

AVIATION – CO_2 EMISSIONS

FUEL CONSUMPTION IN COMMERCIAL AVIATION: IT MATTERS


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- Before Covid, the global aviation industry produced more than 2,4% of all human-induced carbon dioxide (CO_2) emissions.
- In 2017 airliners consumed 341 million tons of jet fuel at a cost of 149 billion USD.
- Prior the crisis forecasts indicated a growth of absolute emissions from aviation will continue to grow with increase in airline traffic (+20% until 2030; +35% until 2040).

Sources ICCT https://theicct.org/publications/co2-emissions-commercial-aviation-2018;
Oliver Wyman – Global Fleet and MRO Forecast https://www.oliverwyman.com/our-expertise/insights/2017/feb/2017-2027-fleet-mro-forecast.html Eurocontrol
https://www.eurocontrol.int/sites/default/files/2019-06/eaer-2019_0.pdf

SETTING THE SCENE - SHARKSKIN

MIMICKING THE SKIN OF A SHARK BY LASER TREATMENT OF THE AIRCRAFT SURFACE ALLOWS TO REDUCE FUEL BURN AND CO_2 EMISSIONS BY UP TO 3 %

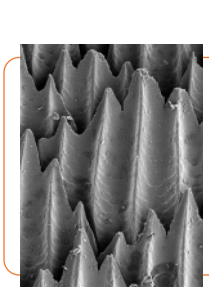
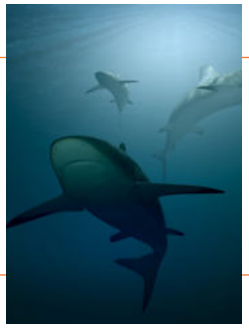
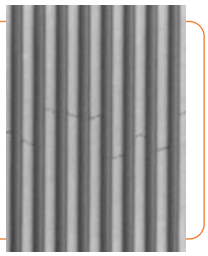


Image of a shark skin

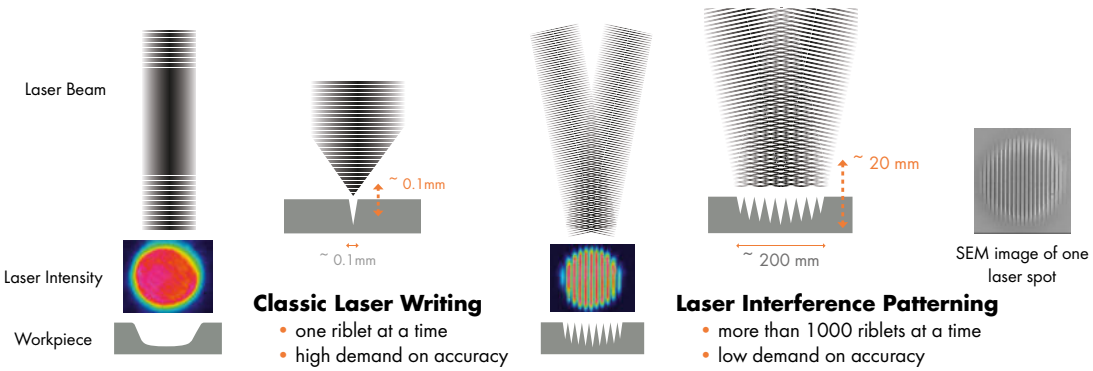




SEM Image of riblets created by laser in a commercial aeropace paint system

LASER INTERFERENCE PATTERNING

SPEED AND ACCURACY – LASER INTERFERENCE PATTERNING ENABLES RIBLET MANUFACTURING BY LASER

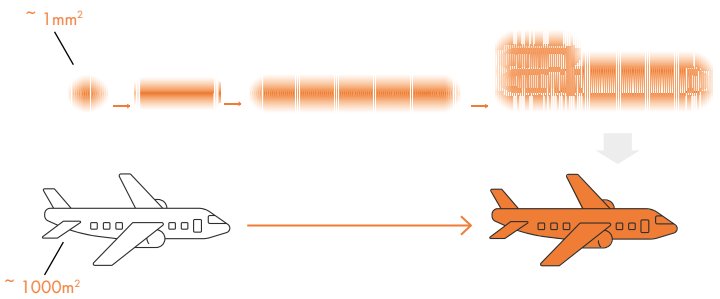


Classic Laser Writing
- one riblet at a time
- high demand on accuracy
- → not feasible

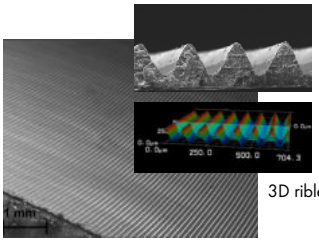
Laser Interference Patterning
- more than 1000 riblets at a time
- low demand on accuracy
- → feasible

HOMOGENEOUS LARGE AREA PROCESSING

FAST AND FLEXIBLE APPLICATION OF PERFECTLY HOMOGENEOUS RIBLETS ON LARGE AREAS BY 4JET'S UNIQUE AND PATENTED APPLICATION TECHNIQUE



SEM image of riblet cross-section



3D riblet topography

SEM image of riblet area

LEAF Technology

RIBLET GEOMETRY

LEAF RIBLET GEOMETRY IN BETWEEN SAW AND TRAPEZOIDAL SHAPE DELIVERS BEST BALANCE OF SPEED, PERFORMANCE AND STABILITY

Performance	+++	++	++	+
Mechanical stability	-	+	++	+++
Speed of application	+	+	+++	+++

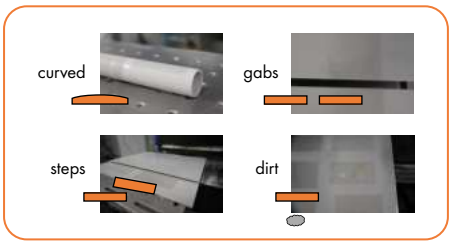
Concave nature and smooth transition at edges of LEAF riblets reduce soiling and erosion while improving aerodynamics.

PROCESS CAPABILITIES

RELIABLE RIBLET APPLICATION ON KEY AVIATION COATING SYSTEMS IN REAL WORLD CONDITIONS

High process stability
- Constant process conditions over time and location
- Large depth of field (→ vibration uncritical)
- Reliable processing of uneven surfaces: rivets, steps, gaps, dirt,....

Material independent riblet processing
- Typical aerospace coatings of various manufactures (AMS 3095B)
- Epoxy or Silicone-based coatings
- Adhesive Films
- All colors

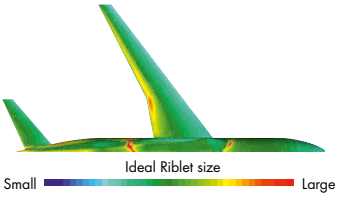


TAILORED RIBLET LAYOUT

HIGHLY FLEXIBLE LASER PROCESSING ALLOWS TO PERFECTLY TAILOR RIBLET DISTRIBUTION TO LOCAL AERODYNAMIC NEEDS

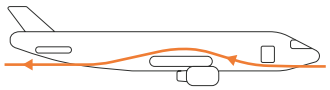
Digital Manufacturing
Riblet size, angle, phase and location can be adapted to local needs, e.g.

- Gradually change riblet size across wing
- Fine-tune riblet angles to local flow conditions
- 3D riblets or free form riblet distributions

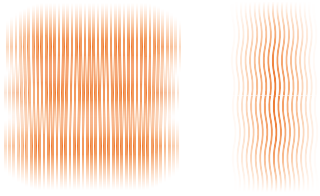


Simulation of ideal riblet size distribution on aircraft

Image: P.A. Leitl1 et al., Bionic Surface Technologies, AIAA SciTech Forum2022, DOI: 10.2514/6.2022-0919



Direction of main airflow

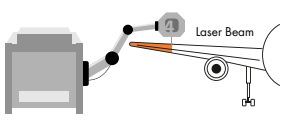


Exemplary possible 3D riblet layouts

DIRECT OR FILM PROCESSING

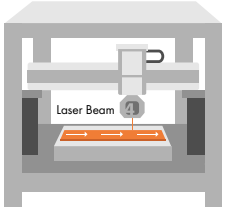
HIGHLY FLEXIBLE RIBLET PROCESSING DIRECTLY ON AIRCRAFT OR ON ADHESIVE FILMS

- Fully automated laser processing directly on fully painted aircraft



Typical Paint System

- Processing of adhesive films with costumized riblet distribution



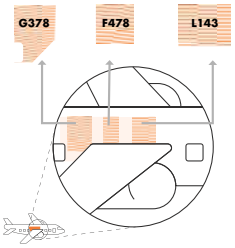
Typical Adhesive Film

WORKFLOW FLEXFILM

DIGITAL MANUFACTURING OF INDIVIDUAL PERFECTLY ADJUSTED RIBLET DISTRIBUTIONS

1. CFD (Computational Fluid Dynamics) Simulation

2. Ideal Riblet Map on Aircraft (best riblet layout)



3. Definition of individual Film Pieces:
- Size and shape of each piece
- Best riblet distribution on each piece
- Result: G378.dat, F478.dat,....

4. Digital Manufacturing