Adhesion tests and laser stripping process of paint using shock waves: Application to Aeronautical Parts in Al alloys and CFRP

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CertBond

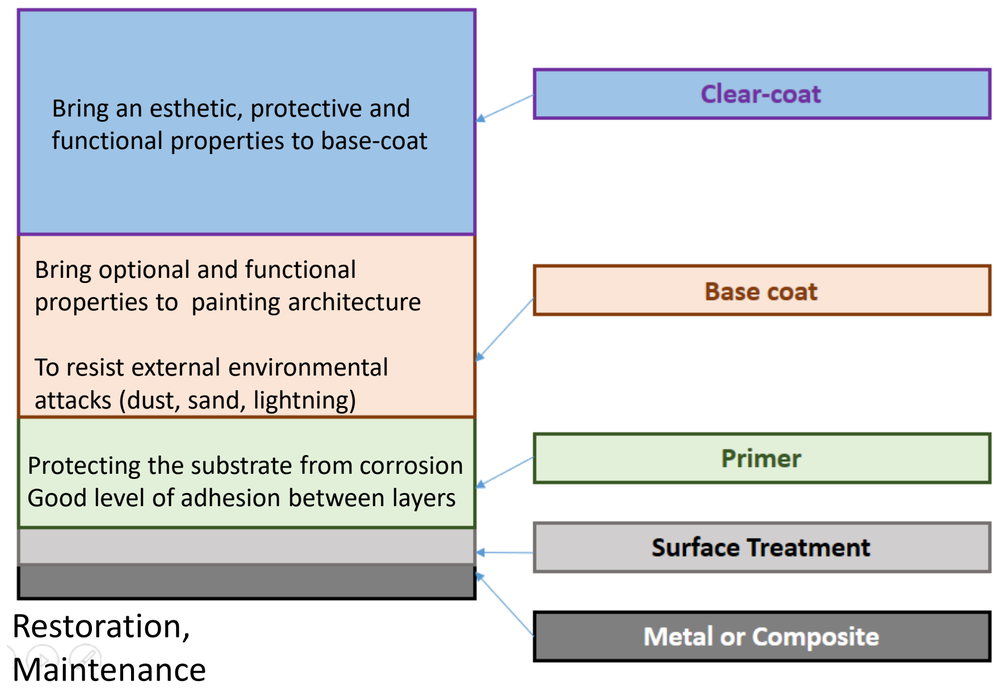
COST Action CA18120

Clean Sky Vulcan Project

GOALS

- Development of an industrial laser stripping process which is able to remove selectively the top coat of an aircraft paint system by keeping the substrate health
- Environmental Friendly

- Universal solution that is applicable for both composites and metals



- Restoration,
- Maintenance
- Routine inspection during their life time

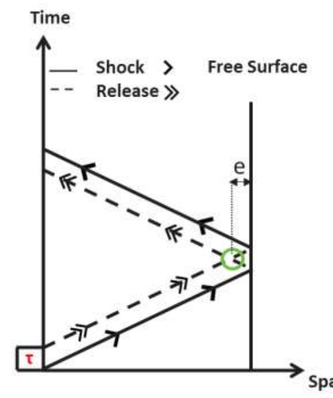
Background & Specifications

Chemical Stripping	• Sensitive areas should be protected during the operation • Waste chemical disposal after the operation
Media Blasting	• Not Selective • Treatment of dust during blasting • Treatment of media after stripping
Laser Stripping	• No use of chemical products • Process can be monitored • Lower investment cost

Concept & Approach

- The tensile location can be shifted by changing laser parameters (duration, pulse configuration)

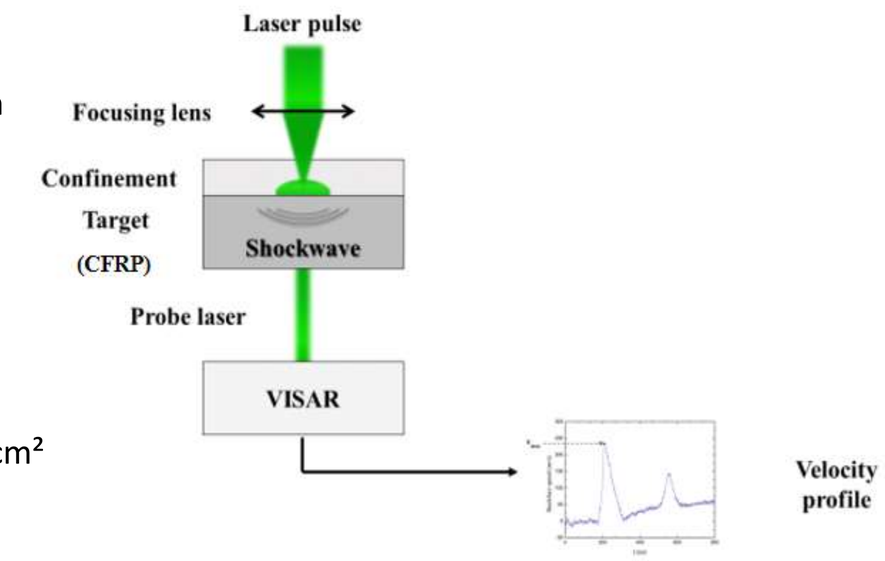
- If the tensile stresses created by the shock waves are lower than the failure stress of the material, no mechanical damage is obtained. For the case of spallation, the tensile stress levels which are created via shock waves are higher than the material's tensile stress [2].



Space-time diagram for a mono pulse impact

Process Parameters

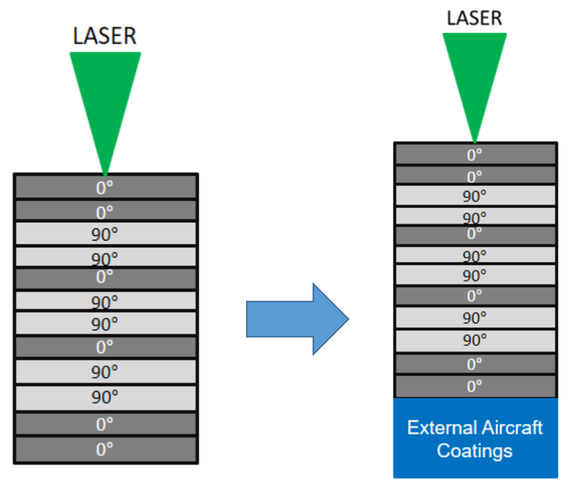
- ❑ Pulse Duration: 8-25 ns
- ❑ Wavelength: 532-1064 nm
- ❑ Energy: 0.2-50 Joules
- ❑ Repetition Rate: 1-20 Hz
- ❑ Spot Diameter: mm
- ❑ Power Density: 1-10 GW/cm²
- ❑ Pressure: 1-8 GPa



Schematic Representation of VISAR Diagnostic *(Le Bras,2019)* [1].

Samples & Methodology

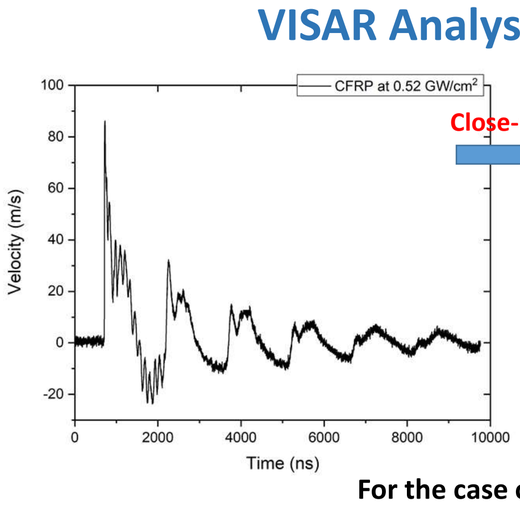
Composite cross-section cut under SEM.



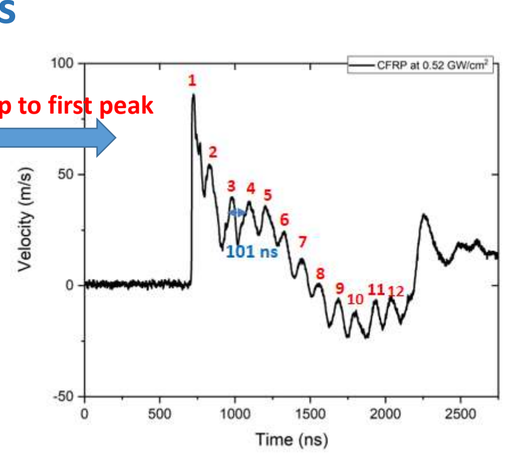
First, debonding threshold calculated via VISAR for base materials
Then, stripping threshold for the paint is calculated for CFRP+External aircraft coatings to verify base material's health as function of different spot sizes.

Results & Discussion

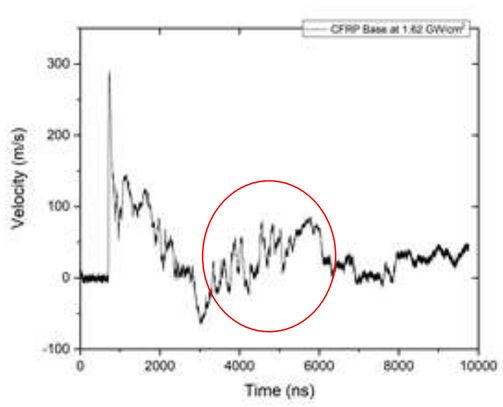
VISAR Analysis



Close-up to first peak

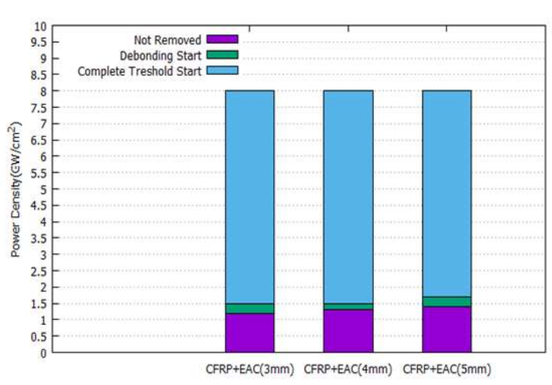


For the case of no damage



For the damage threshold within the composite

Evaluation of the Removal Threshold



Strippiing Threshold Evaluation as function of spot diameter

- With VISAR Diagnostics, we were able to monitor the shock wave propagation within plies. Number of peaks corresponds to the number of plies. It was also monitorable to detect the damage threshold within the composite from the change of the wave propagation.
- The damage threshold for the base material is higher (1.62 GW/cm²) than the stripping threshold for the external aircraft stripping threshold (1.5 GW/cm² for 3 & 4mm spot sizes) which means that without damageing the substrate, we can have a stripping on the composite+EAC with these configuration.
- The stripping rate is calculated as 0.7 m²/h for the composite+eac which is in the framework of the project.

Funded by the Horizon 2020 Framework Programme of the European Union

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

REFERENCES

[1] Le Bras, A. Rondepierre, R. Seddik, M. Scius-Bertrand, Y. Rouchausse, L. Videau, B. Fayolle, M. Gervais, L. Morin, S. Valadon, R. Ecault, D. Furfari, L. Berthe, Laser shock peening: Toward the use of pliable solid polymers for confinement, Metals 9,793 (3) (2019) 1–13

[2] Unaldi, S.; Papadopoulos, K.; Rondepierre, A.; Rouchausse, Y.; Karanika, A.; Deliane, F.; Tserpes, K.; Floros, G.; Richaud, E.; Berthe, L. Towards selective Laser paint stripping using shock waves produced by Laser—Plasma interaction for aeronautical applications on AA 2024 Based Substrates. *Opt. Laser Technol.* **2021**, *141*, 107095