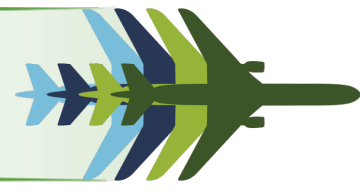


# Ultra-efficient load introduction into composite structures

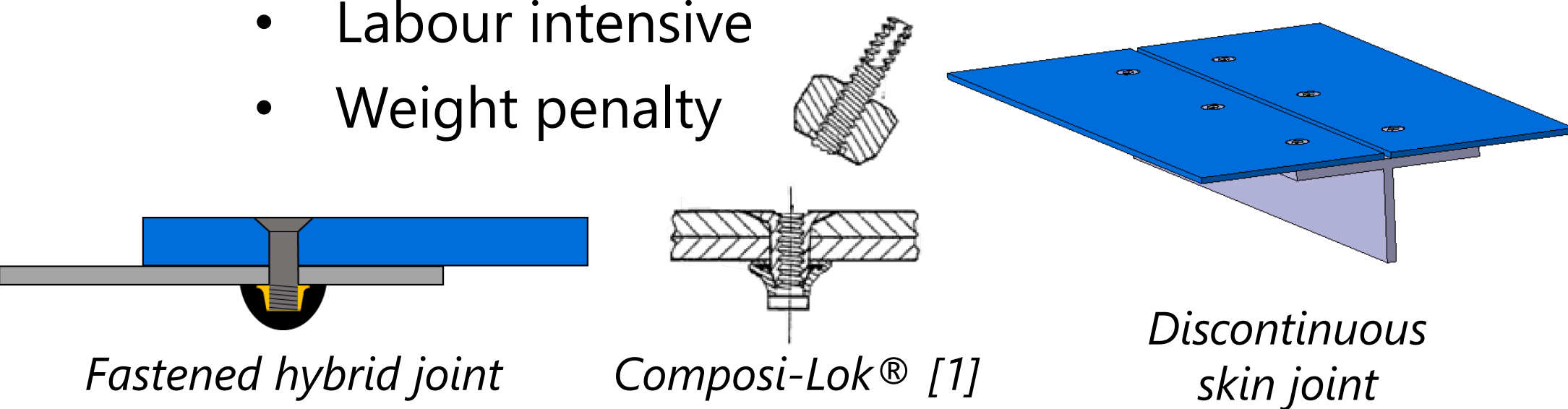
Contact: Royal Netherlands Aerospace Centre | MAMTeC@nlr.nl | © Royal NLR 2024



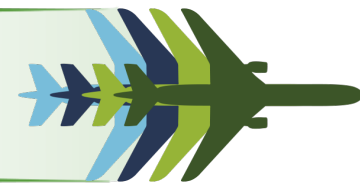
## BACKGROUND



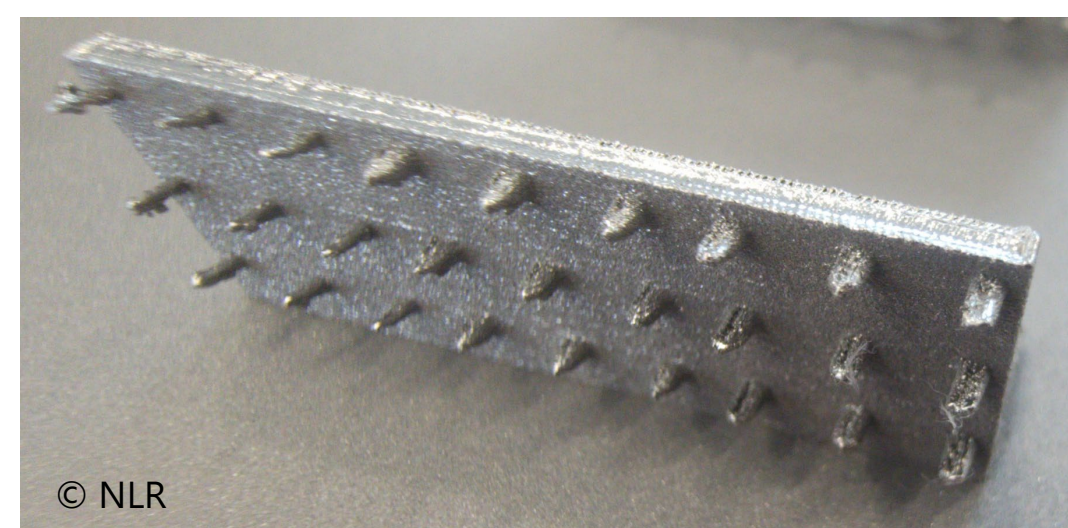
- Lightweight metal-composite joints are essential for future aircraft
- State-of-the-art hybrid joining methods, such as fastening and riveting, are suboptimal:
  - Labour intensive
  - Weight penalty



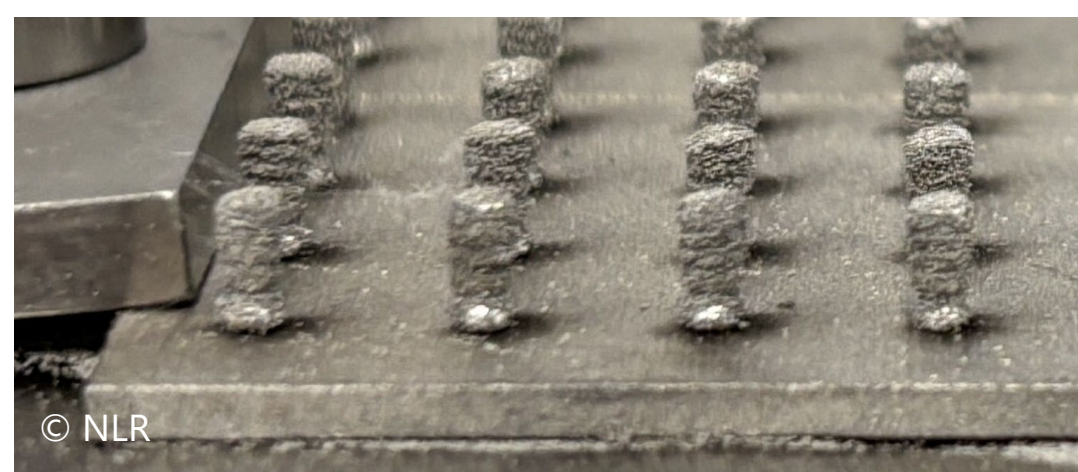
## HOW?



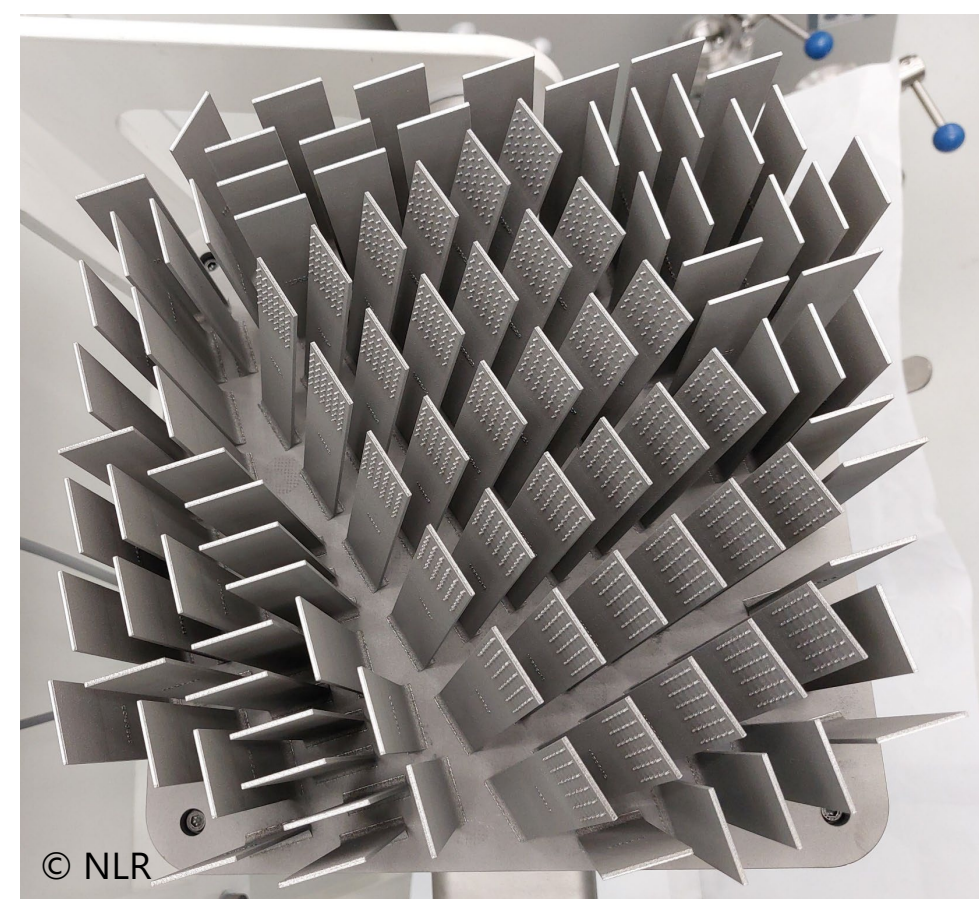
- Study bonding of titanium (Ti6Al4V) and thermoplastic (LMPAEK) hybrid joint
- Study various joining methods:
  - Hot pressing (reference case)
  - Resistance welding
  - Induction welding
- Apply freeform additive manufacturing to tailor faying metal joint surface
  - Laser Powder Bed Fusion (LPBF) pins
  - Directed Energy Deposition (DED) pins



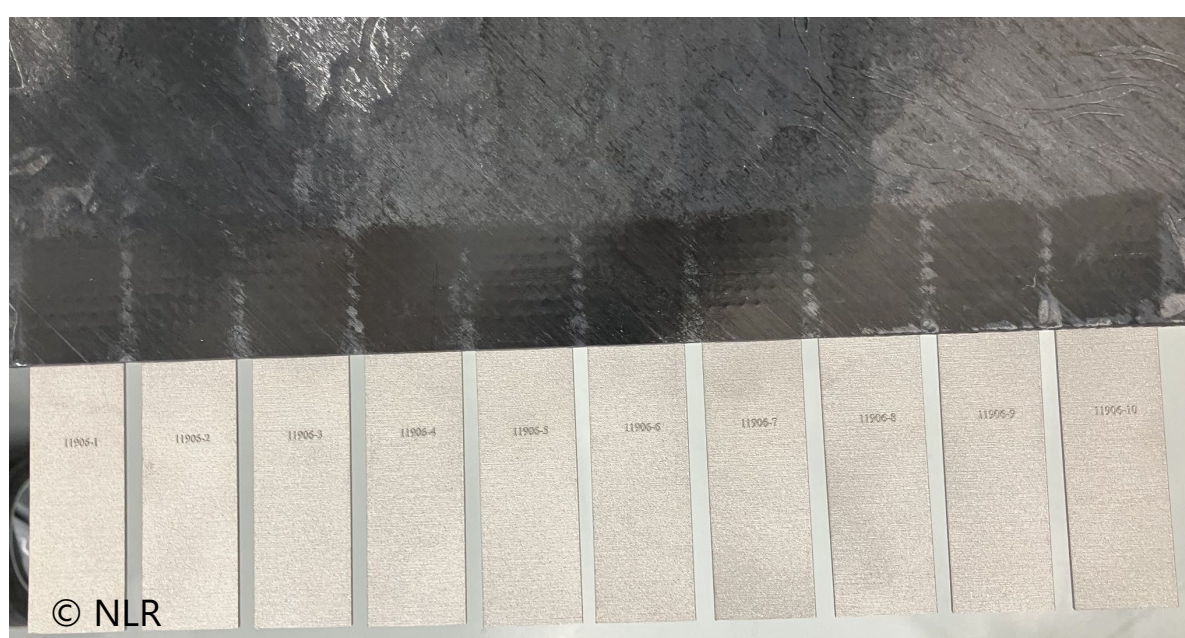
Pins produced by LPBF



Pins produced by DED

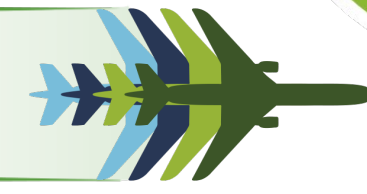


LPBF build plate with 105 titanium Single Lap Shear (SLS) test specimens (left)



Hot-pressed SLS test specimens with pins

## OBJECTIVE(S)



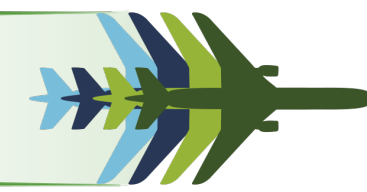
- Develop efficient joining methods for metal-composite structures that are:
  - Reliable (airworthy)
  - Damage tolerant (inspectable)
  - Dis-joinable (repairable)

## WHY?

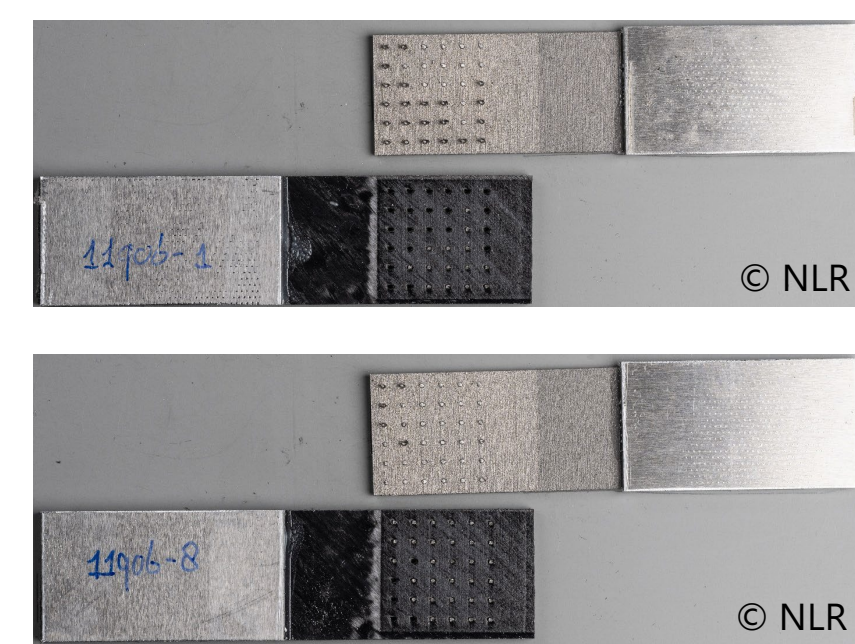
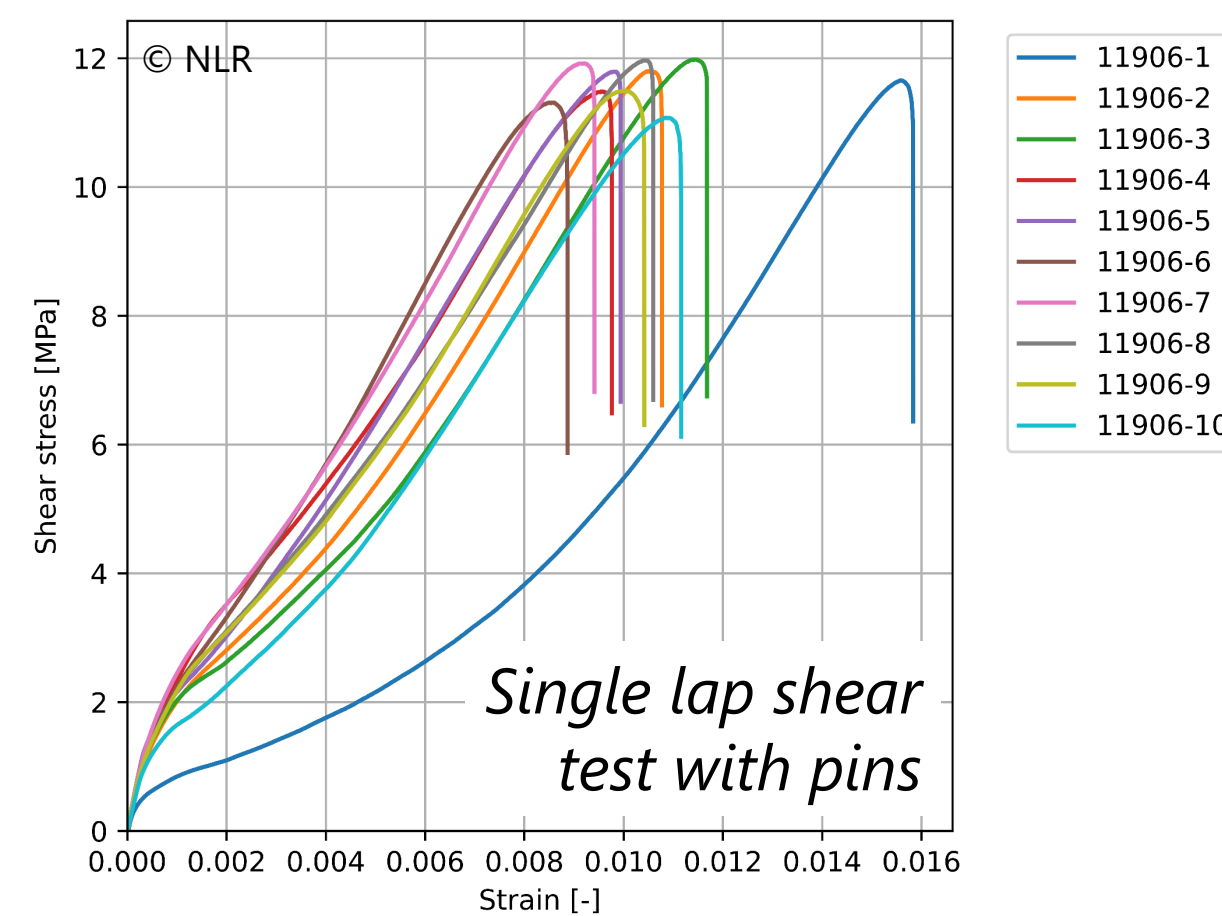


- Increase sustainability
  - Better performance for lower weight
  - Double flush, no extending parts
  - Recyclable, no additional materials
- Increase competitiveness
  - Reduce labour and cost
  - Two-stage failure mode
  - Re-useable

## RESULTS



- Initial shear test results of hot-pressed hybrid titanium-LMPAEK joint
  - Without pins very weak shear strength (<1MPa)
  - With pins consistent failure around 11-12 MPa



Failed specimens with pins being both sheared off and pulled out of the LMPAEK

- Future research activities
  - Collect more statistical data of bond strength
  - Apply laser nano-structuring of bond surface
  - Apply chemical treatment of bond surface
  - Optimize interface geometry
  - Work towards a demonstrator



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### Acknowledgement

This research is conducted within the research and innovation programme Luchtvaart in Transitie, which is co-funded by the Netherlands National Growth Fund

[1] MBF 2300 series Installation and inspection specification: [https://trsaero.com/monogram aerospace/wp-content/uploads/sites/3/2018/03/MBF2301\\_CL\\_3\\_Installation.pdf](https://trsaero.com/monogram aerospace/wp-content/uploads/sites/3/2018/03/MBF2301_CL_3_Installation.pdf)