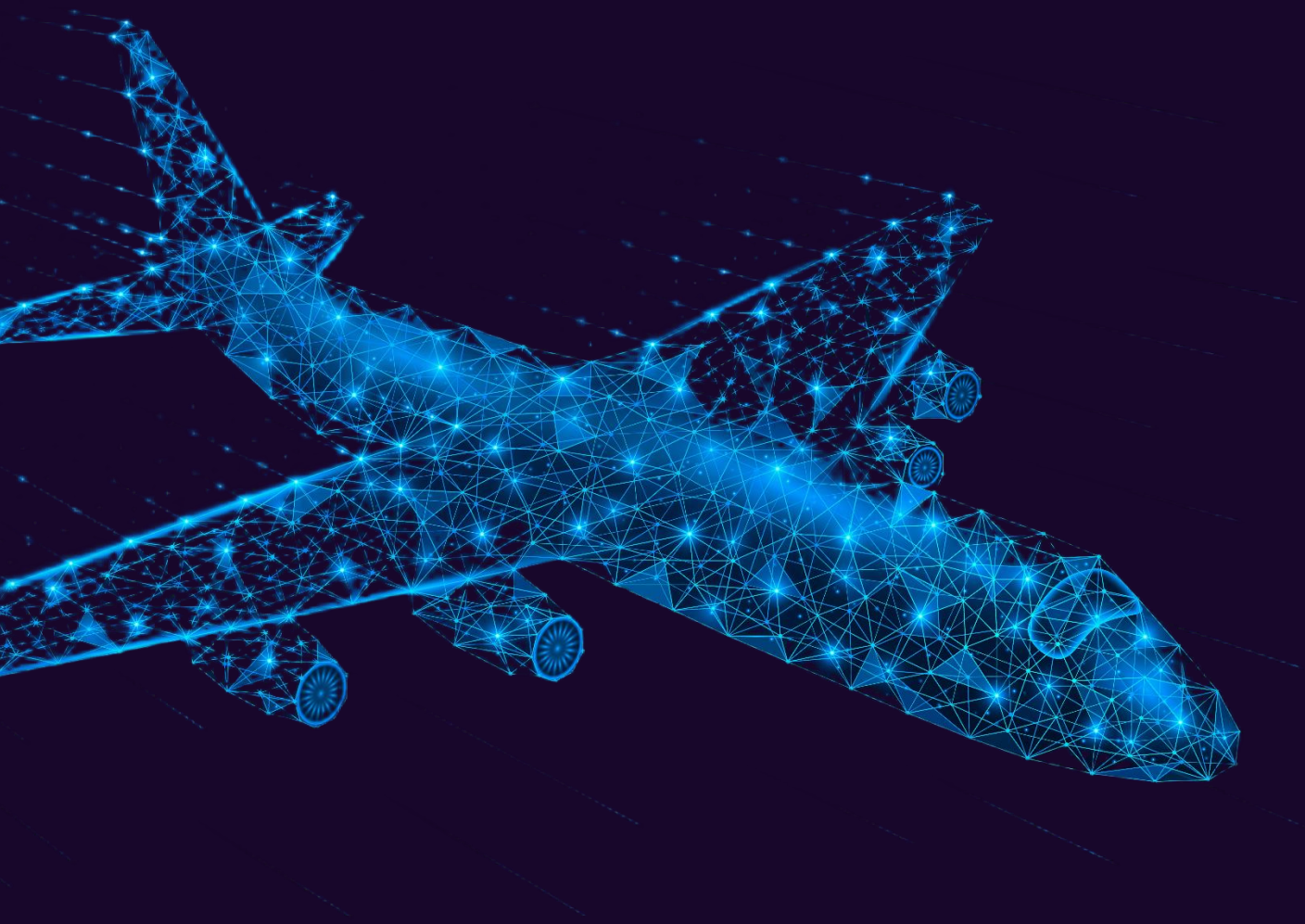
PLEIADES



Technical brochure
photonic sensors

PLEIADES – Advancing Aeros**P**ace Composites Through Induction We**L**ding and New Vitrim**E**ric Formulat**I**ons Enh**A**nced by Integrate**D** Photonic S**E**nsors, Providing Data to Digital **S**upply Chain, SHM, Maintenance.

www.pleiades-project.eu

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Further development of composite materials for aircraft structures

The composites aerostructures market is projected to grow to US$116 billion by 2030, attributed to the increasing demand for advanced materials in aircraft manufacturing which exhibit lightweight properties and can withstand harsh environments, ultimately improving the aircraft performance and cost savings. The PLEIADES project aims to address these needs, making significant steps towards meeting the industry's requirements through its proposed solution.

PLEIADES multiple disciplines extend across a wide variety, such as formulations and characterization of new composite materials, automation of induction welding processes for composites leveraging integrated sensing, disassembly of composites joints, healing and maintenance schedules.

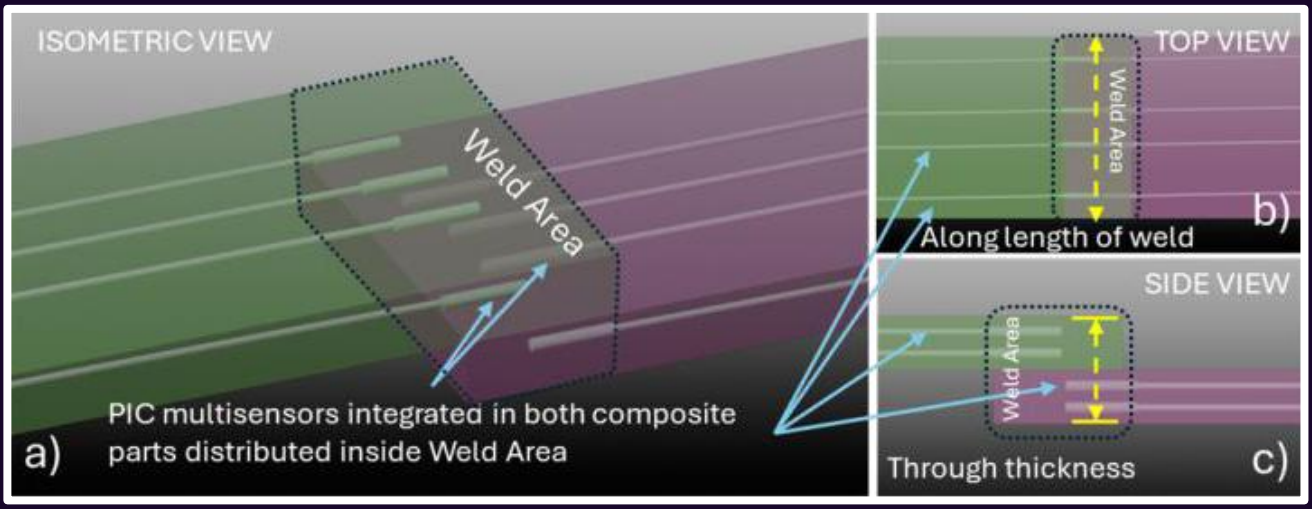
Our technological goals

Technological goals within PLEIADES are the development of passive Photonic Integrated Circuit (PIC) based multi-sensors, the development of a unified quality assurance (QA) - structural health monitoring (SHM) methodology, the extensive modelling for induction welding and the development of material, healing, damage propagation, and deicing models. All of these disciplines will be pursued within PLEIADES and with tangible use cases in aerospace, in synergy with the Clean Aviation partnership to ensure its innovations are aligned with it.

Targeted development of photonic sensors

One core activity within PLEIADES is the development of passive PIC based multi-sensors enhancing existing Fibre Bragg grating (FBG) sensors that will be used to automate the process.

Our aim is to develop a passive, EMI-free **photonic multi-sensor,** suitable for challenging environments — a PIC co-packaged on a **single optical fibre**. This is delivering **Temperature (T), Refractive Index (RI), Pressure (P)** from **inside** the composite parts parts and weld seams.

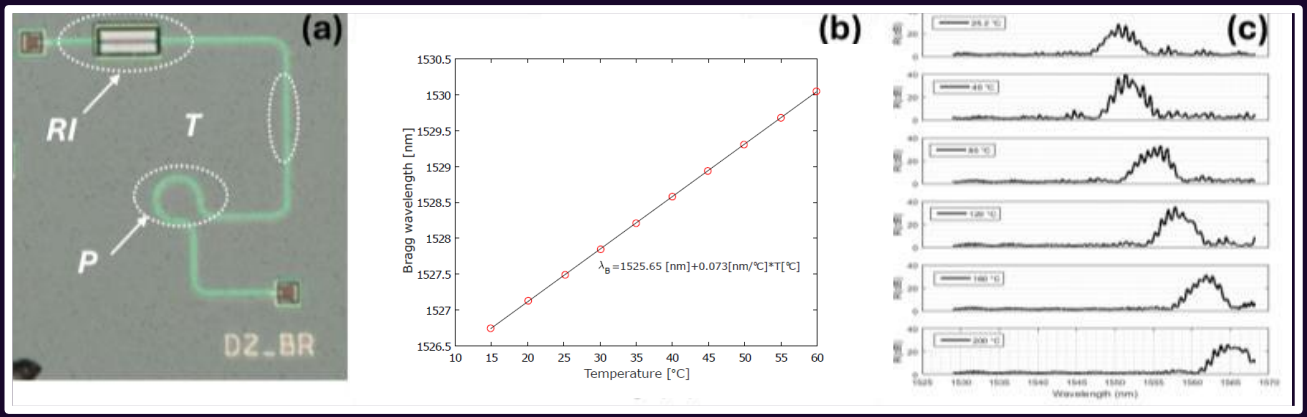


Possible distributions of PICs multisensors during induction welding highlighting measurements:

a) 3D View

b) Top View (along weld seam)

c) Side View (through the thickness)



Example sensor fabrication within the EU project SEER: T, RI, and P multi-sensor fabricated within SEER:

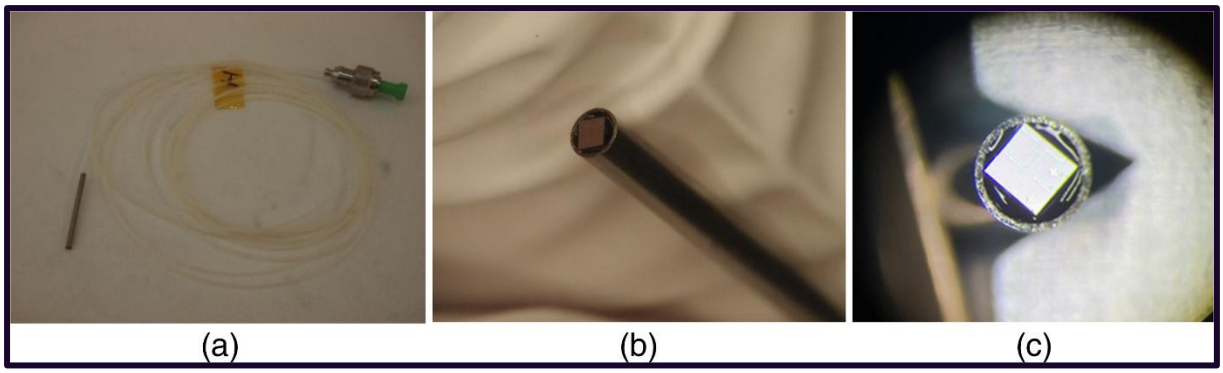
(a) Microscope image

(b) Measured response for the temperature sensor

(c) Reflection spectrum of T sensor RT - 200°C

What's new in development?

The desired chain of functions should be: One fibre, one interrogator, multi-physics truth. In previous projects the partners have already realized temperature sensors based on PICs for composite monitoring. In PLEIADES the partners will enhance them towards multi-sensors and adapt the packaging to make induction welding compatible (avoiding any metals).



Example sensor implementation (source: http://doi.org/10.1117/1.jom.4.1.011005)

SINGLE-FIBRE, MULTI-SENSOR
Stack enabling synchronized T/RI/P/strain in one trace

POINT SENSING AT THE WELD
The Miniaturized PIC element is EMI-free, so it can sit in the induction weld zone to monitor and control the process in real time.

SPECS (TARGETS)
PLEIADES Packaging and design of SiPh (silicon photonic based PICs) will ensure –50 to 400 °C range; ~70 pm/°C T-sensitivity (±0.15 °C accuracy); 2 nm/RIU RI-sensitivity (±0.002 RIU accuracy); 0.1–1 MPa pressure window.

GEOMETRY-AWARE PLACEMENT
Arrays along seam length and through thickness decouple T/RI/P for robust control and model validation.

Why it matters (impact)

LEANER, GREENER WELDING

Embedded data drive closed-loop control to cut cycle time and energy ~25% and keep batch CoV <10% (quality & process repeatability targets).

DESIGNED FOR CIRCULARITY

In-situ T/P thresholds guide non-destructive disassembly and rebonding of induction welds, protecting adherends.

TRUSTABLE SHM

Unified NDT↔SHM framework (LDV + embedded photonics) targets ~30% fewer false alarms and ~90% lower training effort

SHARPER SENSING → FASTER ACTION

Model-driven integration targets ~30% sensor-accuracy improvement, ~60% faster damage detection, and ≤10% better localisation precision vs. state-of-the-art.

PLEIADES partners

Work package 6 | sensor development

imec

Collins Aerospace
An RTX Business

ΕΠΙΣΕΥ
ICCS

Cranfield University

TWI

Further partners

Brunel Composites Centre

EuCIA
The European Voice of Composites

EtS
Engineering Technology Solutions

evektor

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