Accelerating the future of aerospace

Automated Composite Manufacturing Technology Centre

Royal NLR - Netherlands Aerospace Centre

Composite facilities

Automated Composites Manufacturing
ACM Pilot Plant
Large scale additive manufacturing

STUNNING, MULTIFUNCTIONAL FUSELAGE DEMONSTRATOR

Automated composites manufacturing

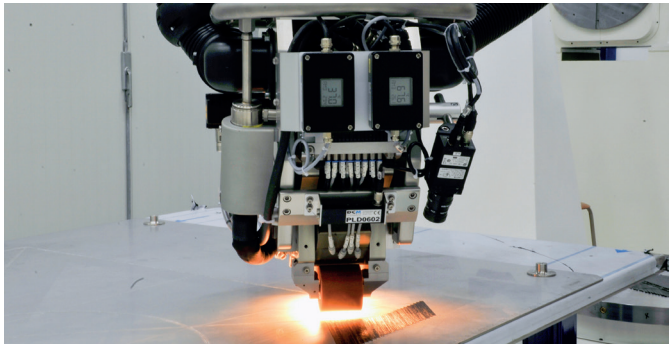
The Automated Composite Manufacturing Technology Centre (ACM-TC) and the Automated Composite Manufacturing Pilot Plant (ACM-PP) were established at NLR in the Netherlands to prepare the way towards automated manufacturing of advanced composite structures, largely in support of the 'composites' industry, but also of enterprises, which are new to this material. The centre brings together the complementary research capabilities of research centres, universities and specialised small enterprises and industries. ACM-TC operates at Technology Readiness levels TRL 3 - TRL 6 where the ACM-PP operates at TRL 6 - TRL 8.
The vision of the ACM is 'to pioneer innovative fabrication technologies for composites with potential for automation' and thereby 'to enhance the competitiveness of its members', by conducting applied research and carry out development programmes up to the level of full scale prototypes.

OUR CAPABILITIES

- Design concepts in composite
- Detailed finite element calculations for composite designs
- Trade studies to evaluate different design concepts
- Cost modelling
- A second opinion on composite designs
- Composite manufacturing
- Full scale prototyping
- Mould design and manufacturing
- Automated Fibre Placement
- Resin Transfer Moulding
- Vacuum assisted Resin transfer moulding
- Automated Composite Manufacturing (e.g. Pick & Place)
- Press forming
- Braiding
- Induction welding

WHAT WE DELIVER

Extensive experience with, and knowledge of, Polymer Based Composite Materials, manufacturing processes, the mechanical behaviour of composite materials and the structural response of composite structures. We perform activities for the 'High Tech-High Spec' community like aerospace, automotive, maritime, rail, transport and medical.



Automated Composite Manufacturing Pilot Plant

The NLR automated composites pilot plant, ACM³ Fieldlab, aims to attract Small- and Medium-sized Enterprises (SMEs). This well-equipped, state-of-the-art field laboratory makes high-tech equipment available for the development of light-weight products.

The purpose of ACM³ (Fieldlab for Automated Composites Manufacturing, Metal Manufacturing and Maintenance) is to support companies in the development of light-weight systems made of composite materials and/or metal. NLR can provide this support in nearly all phases of product development: from concept studies and material screening to preparing detailed designs and creating concepts. Repairs and full-scale prototyping are also carried out in the centre. ACM³ is optimizing accessibility in various ways. For instance, a 'menu' of the available equipment has been prepared to provide quick insight into the facilities and their operation. This allows companies to discover at a glance what they can do at ACM³. Users can receive training or hire an NLR operator if the equipment is too complex for unassisted operation. During the production of a pilot run, for instance, users can receive training to ensure that properly qualified personnel is available when actual serial production starts at the customer site.

AFFORDABLE PROTOTYPES

The centre particularly offers benefits for SMEs. Without any requirement for major investments, they can join forces with NLR and use the equipment available at ACM³ to work on the development of new light-weight products and the required manufacturing technologies. This process can start with 'proof of concepts' that are eventually developed into full-scale prototypes.

Another benefit is the ability to postpone capital investments until there is more certainty about the commercial potential of the product. The facilities at ACM³ enable companies to delay the ordering of production equipment until there is greater certainty of a successful market introduction. In order to bridge the intervening period and maintain market momentum, companies can use ACM³ equipment to produce the initial pilot runs.

One recent achievement illustrating the potential of ACM³ is the successful development of PAL-V: the world's first flying car production model, equipped with unique collapsible rotor blades. Designs for the composite rotor blades and propeller were developed and tested in the NLR Fieldlab. The required manufacturing method was also developed here.

Equipment for manufacturing composite components

PREFORM CELL

This cell comprises of :

- Zünd cutting machine
- Kuka robot with end effectors for pick and place, preform
- trimming and tool handling
- Global vacuum press with infra-red heating
- Assembly Guidance laser vision system

RESIN TRANSFER MOULDING

The RTM station consists of a dedicated Isojet injection system for one component resin systems with water heaters for resin tank, injection hoses and product moulds. The closing of the moulds can be controlled by multiple presses. Online process monitoring by digital twin.

BRAIDING

The Eurocarbon overbraiding machine consists of two concentrically mounted braiding rings with 144 and 288 carriers. The two braiding rings can be used to manufacture products with a broad range of cross sections from below ø 50 mm to over ø 600 mm depending on tow size, fibre angle and cover factor. The machine can also be used to manufacture tri-axial braids.

INDUCTION WELDING

The cell with a Kuka robot, induction power generator and welding end effector is used to develop automated welding processes for thermoplastic sheets and stringers. Different set-ups can be positioned in the cell for process optimisation.

Equipment for manufacturing composite components

AUTOMATED FIBRE PLACEMENT MACHINE

A Coriolis fibre placement machine is used to develop structural components in thermoset and thermoplastic composites as well dry fibre preforms. The robot based Coriolis machine is capable of making components with a maximum diameter of 4.0 m and a length of 8.5 m in the horizontal spindle. For processing thermoplastics or dry fibres a 6 kW laser heating is used. For processing thermoset materials an infrared heater is used. Early 2026, an MTORRIS fibre placement machine will be installed to complement the AFP facilities.

AUTOCLAVE

An autoclave is available equipped with automated data logging of temperatures, pressures and vacuum.

- Working volume 5.5 m^3
- Heat output 70 kW
- Temperature (max) 400 °C
- Pressure 20 / - 1 bar
- Medium Air or nitrogen

VACUUM INFUSION

A dedicated Isojet machine is available for vacuum infusion. Like the RTM machine it is designed for processing one component resins. The maximum resin capacity is 30 litres. The machine is equipped with an electrical heating system both for the resin tank and the tooling.

HEATED PRESSES

Two heated presses are available for press forming and curing with thermoplastic and thermoset materials. A larger press will be installed in the first quarter of 2026. Presses can be used in combination with infrared heaters and automatic/robotic loading systems.

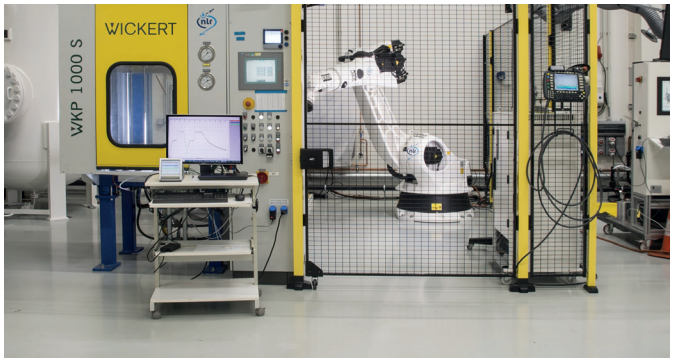
The main characteristics of the presses are:

- Langzauner: 500 x 500 mm, 5/350 kN
- Wickert: 600 x 600 mm, 20/1000 kN
- Langzauner: 2400 x 800 mm, 35/6500 kN (oil heated)
- Temperatures up to 400 °C

LARGE CURING OVEN

A large curing oven is available for curing or consolidating large products

- Internal size 3.4x3.4x8.0 m
- Temperature (max) 400 °C



Equipment for analysis and characterisation

RHEOMETER

With the Anton Paar rheometer MCR302, viscosity measurements can be carried out in the temperature range of -40 °C to 620 °C. In the oscillation mode with plate-plate Ø 40 mm, viscosities between 40 kPa.s and 1 mPa.s can be measured. The maximum heating rate is 60 °C/min.

DIFFERENTIAL SCANNING CALORIMETER (DSC)

The Discovery DSC 2500 with autosampler from TA Instruments is used to study curing, ageing, melting, crystallisation and specific heat (Cp) of thermosets and thermoplastics at temperatures between -90 °C and +725 °C with heating rates up to 200 °C/min and cooling rates up to 100 °C/min. Modulated DSC (MDSC) is possible. Typical sample size is 15 mg. The sensitivity is <10 µW.

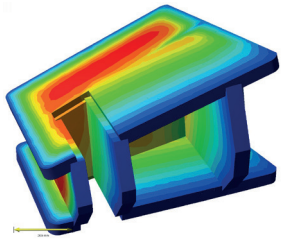
THERMOGRAVIMETRIC ANALYSIS (TGA)

Moisture-, volatile- and resin content are measured with the Pyris 6 TGA from TA Instruments at temperatures from 5 °C up to 1000 °C on test specimens up to 1500 mg. Maximum heating rate is 50 °C.

SUPPORTING SOFTWARE

In support of the composite manufacturing activities, several software applications are available:

- CATIA V5
- CATIA CPD
- CATFiber
- Fibersim
- ESI PAM Composites
- MSC Nastran / Patran
- Abaqus
- AniForm



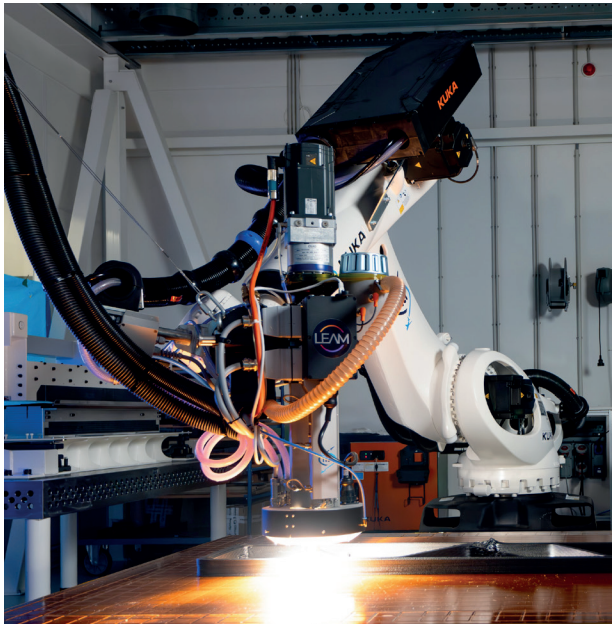
NON DESTRUCTIVE INSPECTION (NDI)

Different NDI technics are avialable for inspection of components like:

- C-scan with a scan window of 4.0x2.5x2.5 m
- Phased array ultrasonics
- Shearography
- Lock in Thermography

Large scale additive manufacturing

The CEAD S25 extruder with LEAM Directed Energy Material Extrusion device is used to 3D-print short fiber reinforced thermoplastic materials including LMPAEK & PPS. The size of the extruder and its mount within NLRs robot cell opens the possibility for large size 3D printing of parts up to 2 meters in length. The system is equipped with a next generation motor of 2.7 kW which increases manufacturability of highly viscous composite materials. The large scale printing technology is used in applied research for applications such as high temperature tooling & grid stiffened structures on top of composite laminates. Key benefits of the technology include its design freedom, reduced lead time and the possibility to recycle materials and re-use.



The main characteristics of the S25 extruder are:

- Max. material output: 25 kg/h
- Max. material temperature: 410 °C
- Motor power: 2.7 kW
- Nozzle size: 2-18 mm
- Material feedstock: Automatic hopper loader with dryer
- Substrate heater for previous layer temperature control

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