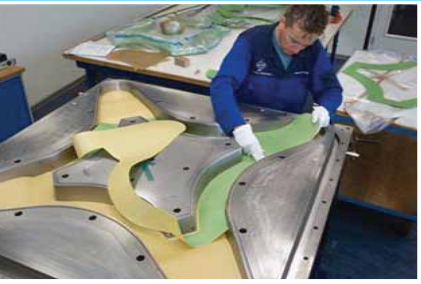
Overview of R&D facility for composites manufacturing





NLR
National Aerospace Laboratory NLR
composites@nlr.nl
+31 88 511 42 86

The composites facility provides NLR the capability required for developing fabrication methods and structural concepts in composite for aircraft and other lightweight structures.

The facility has a total floor area of 600 m^2 and includes rooms for:

- Thermal analysis of composite materials
- Laminating and curing composites using autoclave processing
- Automated Fibre Placement of thermoset, thermoplastic materials and dry fibres
- Press forming of thermoset and thermoplastic materials

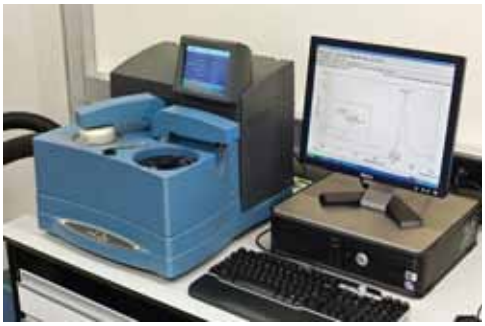
"EQUIPMENT FOR THERMAL ANALYSIS AND CHARACTERIZATION OF COMPOSITE MATERIALS"

Rheometer

With the Bohlin Instruments Rheometer CVO 50NF, viscosity measurements can be carried out in the temperature range of -10 °C to +450 °C. In the oscillation mode with plate-plate ⊠40 mm, viscosity's between 800 Pa.s and 8 mPa.s can be measured. The maximum heating rate is 30 °C/min.

Differential Scanning Calorimeter (DSC)

The DSC Q2000 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 +550 °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 0.2 mW.



Thermogravimetric Analysis (TGA)

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

Permeameters

In-plane permeability of composite preforms can be measured on preforms of 480 mm by 190 mm and up to 4 mm thick. Through the thickness permeability can be measured on preform discs with a diameter of 90 mm.

"EQUIPMENT FOR MANUFACTURING COMPOSITE COMPONENTS"

Autoclave

An autoclave is available, standard equipped with four fixed thermocouples and four vacuum circuits. Optionally twelve thermocouples can be installed. Data is automatically stored in a computer network.

Working volume	5.5 m^3
Heat output	70 kW
Temperature (max)	400 °C
Pressure	20 / - 1 bar
Medium	Air or N_2

Heated press

With the Wickert WKP 1000 S press forming of thermoset and thermoplastic materials can be carries out. The press can also be used in support of Resin Transfer Moulding (RTM) processes. The main characteristics of the press are:

- Product space: 600 × 600 × 600 mm
- Both position and pressure controlled
- Pressure between 20 and 1000 kN
- Temperature up to 400 °C
- Accurate displacement: +- 0.03 mm

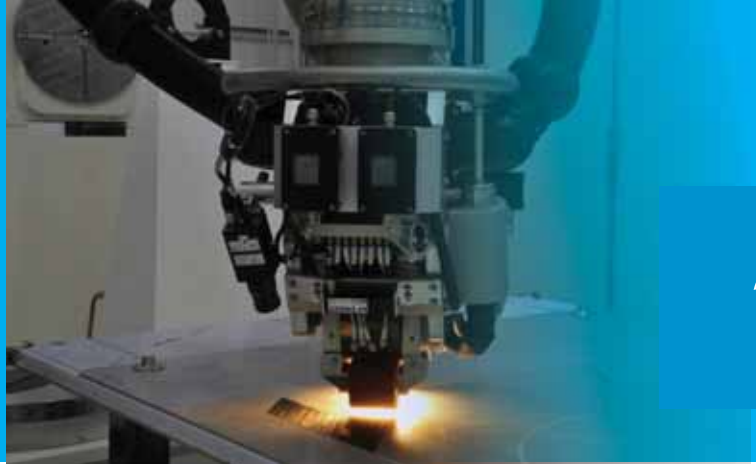
Resin Transfer Moulding machine (RTM)

One of the core activities within the composite facility of NLR is Resin Transfer Moulding (RTM). For this purpose a fully automated RTM machine is available. The machine is used to inject one-component resin systems. Several process parameters can be logged and automatically stored: resin weight, temperature of the resin container, temperature of injection hoses and the injection pressure. In order to heat RTM mould several oil heater units can be used.

Capacity	80 litre
Maximum injection pressure	10 bar
Maximum resin temperature	150 °C

Cutting machine

For cutting sheets of various materials (e.g. pre-preg and dry fabrics), NLR has available an electronically controlled cutting machine with a standard working area of 1600 mm by 1220 mm.



"FULL SCALE PROTOTYPING"

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 3.0 meter and a length of 6.5 meters in the horizontal spindle configuration andis capable of making components with a maximum diameter if 4.0 meter and a lenght of 2.0 meter in the vertical spindle configuration. For processing thermolastics and dry fibre a 6 kWatt laser heating is used. For processing thermoset materials an infra-red heater is used.

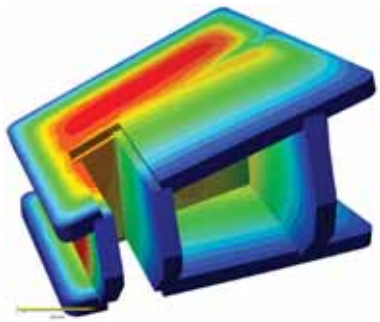
Non Destructive Inspection (NDI)

A C-scan is available for Non-Destructive Inspection. Rectangular components of sizes up to 900 mm by 2400 mm and curved components with diameters up to 900 mm can be tested.

Supporting software

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

- V5r20
- Fibersim
- RTM-Worx
- MSC Nastran / Patran
- Abaqus



National Aerospace Laboratory NLR
Amsterdam – Anthony Fokkerweg 2 ▪ 1059 CM Amsterdam ▪ P.O. Box 90502 ▪ 1006 BM Amsterdam ▪ The Netherlands
Flevoland – Voorsterweg 31 ▪ 8316 PR Marknesse ▪ P.O. Box 153 ▪ 8300 AD Emmeloord ▪ The Netherlands

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