INFORMATION

AEROSPACE MANUFACTURING TECHNOLOGY

Fibre Placement and Autoclave Processing

The use of composite materials in the aerospace industry depends on the manufacture of cost-effective and high-quality composite structures. Currently, the autoclave is the principal equipment for producing such high-quality parts. It can be used to bond composites and produce large aircraft components, such as wing and fuselage components. It can also process a wide variety of materials, including thermosets and thermoplastics, as well as parts with different and complex shapes.

Research is required, however, to improve its efficiency and cost-effectiveness through application of cure sensing, process control, and low-cost tooling technologies. NRC Aerospace is using a large autoclave acquired in 2002 to investigate these technologies, as well as for industrial production. The autoclave has the additional advantage of being able to cure composites at temperatures up to 420°C (850°F).

Cure sensing
Efforts are being made to improve the consistency and efficiency of the composites manufacturing process through on-line cure sensing, which can improve process development time and process repeatability by adjusting the cure cycle to eliminate influences caused by variations in the materials, equipment malfunction, or ambient environment. Part quality is controlled during processing, rather than post-cure inspections, which leads to higher-quality components and reduced fabrication costs. Current investigations are underway at NRC Aerospace to determine the practicality and economic benefit of using dielectric and ultrasonic cure sensing systems in aerospace composites manufacturing.


Autoclave

Fibre placement
Investigations are also being carried out with fibre placement, a cost-effective and highly automated manufacturing process that can replace the labour-intensive hand lay-up of composite materials prior to curing in an autoclave. The technology, which combines filament winding with automated tape placement, is best suited to the production of medium to large-sized parts with moderate to high degrees of curvature and a high level of structural integration.

Equipment
- Autoclave
  - Inside working space: 1.8 m (6’) diameter x 6 m (20’) long
  - Maximum pressure: 300 psi
  - Maximum temperature: 420°C (850°F)
  - Advanced computer control system.

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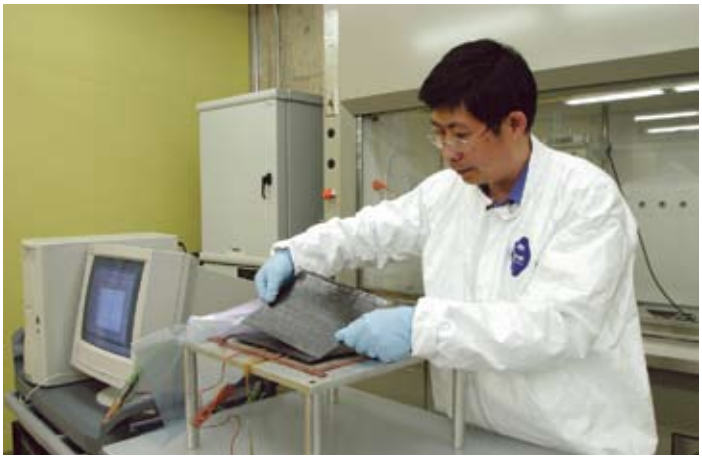
- Cure sensing systems and material characterization
  - DEA 230/10 dielectric sensor system with 10 channels to monitor samples at different locations
  - Material characterization equipment including:
    - Modulated differential scanning calorimetry
    - Dynamic mechanical analyzer
    - Thermogravimetric analyzer
  - Ultrasonic system with PR35 pulser/receiver
  - Operates in both pulse/echo and through-transmission mode.

- Fibre placement
  - Overhead gantry robot with a fully integrated spindle system
  - Fibre placement machine with 6 axes of motion:
    - 3 linear motions (longitudinal X, lateral Y and vertical Z)
    - 3 rotational motions (yaw, roll and spindle)
  - Working envelop: 4 m long x 2 m wide x 1 m diameter
  - Thermoset fibre placement head: 8 tows with 3.175 mm (0.125”) width
  - Thermoplastic fibre placement head: 1 tow with 6.35 mm (0.25”) width
  - Heating system: gas torch (electrically heated nitrogen).



Setting up a cure monitoring test

Fibre placement machine

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