Laser Processing: Process Development

Laser Cutting of Dry Carbon Fibre Preforms

In collaboration with the NCC, the MTC investigated laser cutting 5 mm thick dry carbon fibre preform, benchmarked against the current industry standard practice. Laser cutting promises to reduce cycle times, improve productivity, and minimise the need for reworking of components.

"Being able to leverage the laser processing expertise at the MTC is a fantastic resource, and collaborative work such as this allows us to deliver great value to our customers."

Enrique Garcia, Chief Technology Officer; National Composites Centre

The current gold-standard for automated cutting of carbon fibre fabric is an ultrasonic knife, favoured for its very high cutting rates on single plies. However, the effective cutting speed is drastically reduced on laminated fabric (e.g., 0.3 m/min at 5 mm thickness) and presents cut quality issues with certain fibre orientations.

There is also increased risk of damage to the ultrasonic knife when cutting thicker material or cutting across fibres. In many structural applications, such as aerospace and automotive, thick sections of carbon fibre are required to safely sustain the applied loads.

The National Composites Centre requested the MTC’s Laser Processing team to advise on the suitability of laser cutting for thick dry carbon fibre preform, with a focus on reducing cycle times and improving process efficiency.

THE CHALLENGE

MTC’S SOLUTION

The MTC conducted feasibility trials on behalf of the NCC, to cut dry carbon fibre preform using two different laser systems; a bespoke single mode laser cutting system, and a Synova LCS305 water jet guided laser (WJGL).

- Single mode laser sources are capable of high-power densities and small focal spots, enabling highly precise and efficient cuts across a variety of materials.
- The Synova LCS305 WJGL uses a hair thin water jet to guide the laser beam to the material giving very clean edges whilst cooling the cut and reducing thermal damage.
High-rate dry fibre preform trimming is recognised as an industry gap. The MTC have shown laser trimming to be an attractive alternative to the industry standard with the potential to massively increase cutting speeds.

Dominic Stratton, Research Engineer; National Composites Centre

THE OUTCOME

- The WJGL system produced very high-quality cuts but had slow cutting speeds.
- The single mode laser system produced good quality cuts at a competitive cutting speed.

Using the single mode laser system, the following were achieved:

- The maximum cutting speed achieved for 5 mm thick material was 6 m/min (20× greater than conventional methods).
- Using the speed optimised parameters, a maximum cut depth of ~6 mm could be obtained.

BENEFITS TO THE CLIENT

- Cutting thick sections directly reduces the number of manufacturing processes required, improving process efficiency.
- The laser was equally effective at cutting irrespective of fibre orientation, reducing the need for subsequent reworking processes.
- Non-contact, wear-free cutting eliminates tool breakage, increasing machine utilisation.
- Thick sections are less damage prone than single layers during manipulation, which reduces waste.

Example of material mounted within Innolas SML system

Optical micrograph of SML cut entrance

Increased processing flexibility

Reduced manufacturing steps & tool damage

20× Greater Cutting Rate