Li-ion Battery Separator Foil Cutting Using Nanosecond UV Lasers

In the quest for clean energy, many advances have been made in lithium-ion battery manufacturing technologies in recent years. The increase in the use of mobile devices and electrical vehicles are directly related to the growth of the battery manufacturing industry to produce higher capacity compact, longer lasting batteries that can operate safely.

Typical Li-ion battery cell structures consist of three layers of foils: anode, separator, and cathode foils, as shown in Figure 1. The separator foil is a permeable membrane placed between a battery's anode and cathode foils. The primary function of the separator foil is to prevent physical contact and electrical short circuit between the anode and cathode, while facilitating ion transport in the cell that is needed for battery operation. Separator foils are typically milky white colored 10~30 µm thick porous films with high wettability, mechanical strength, and thermal stability. Polyethylene (PE) or polypropylene (PP) microporous membranes are commonly used for separator foils.

In a typical Li-ion cell manufacturing process, the electrode and separator foils start out as rolls of film that need to be tailor-cut to the required shape before they are stacked, folded, sealed, and packaged into a battery. Laser foil cutting provides many advantages over mechanical foil cutting techniques: it is a high-speed, high-precision, contact-free, cost-effective process with no tool wear, and it enables highly flexible pattern cutting, resulting in improved edge quality.

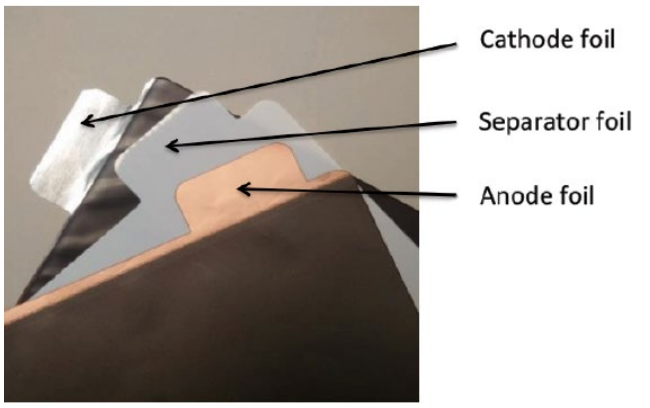

Figure 1: Li-ion battery electrodes and separator foils.

We at Spectra-Physics® have shown that our Talon® UV family of lasers is well suited to cut separator foils. Figure 2 shows a simple experimental setup that we used to cut 20 µm thick PE film. A galvo-scanner based set-up with a beam expander and a beam attenuator gave us a focused beam spot of 20 µm using 250 mm focal length lens.

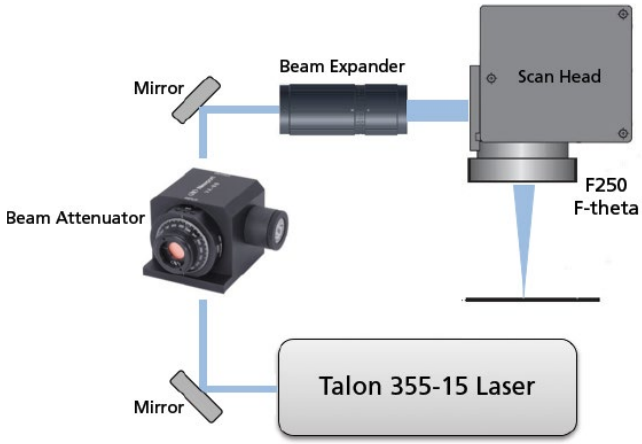

Figure 2: Schematic of experimental set-up used to cut separator foils.

PE films were cut at a speed of 1500 mm/s with excellent cut quality as shown in Figure 3. A heat affected zone of <25 µm was observed at the cut edge. An example of a resulting full profile cut separator PE film with good clean edges is shown in Figure 4.

Separator foils play an important role of keeping electrodes separate in Li-ion batteries to safeguard against any potential short circuit. High speed and high quality laser cutting of separator films was successfully demonstrated with Spectra-Physics' Talon 355-15 nanosecond UV laser.

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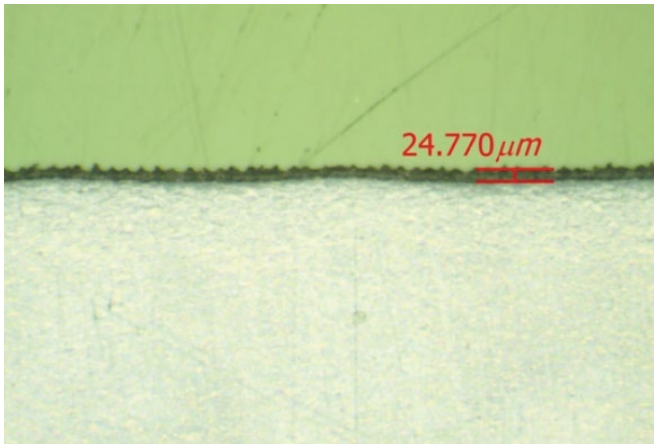

Figure 3: Optical micrograph of a 20 µm thickness microporous PE film cut with a Talon 355-15 laser.

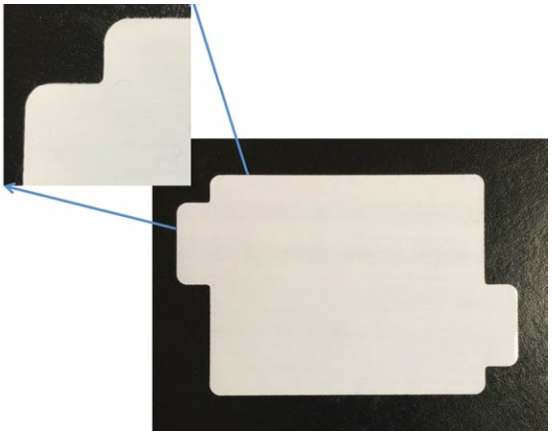

Figure 4: Full profile cut PE separator film using a Talon 355-15 laser.

PRODUCTS: *TALON 355-30, 355-20, TALON 355-15, TALON 355-12, TALON 355-6*

	Talon 355-30	Talon 355-20	Talon 355-15	Talon 355-12	Talon-355-6
Output Characteristics					
Wavelength	355 nm	355 nm	355 nm	355 nm	355 nm
Power	30 W @ 100 kHz	20 W @ 100 kHz	15 W @ 50 kHz	12 W @ 50 kHz	6 W @ 50 kHz
Repetition Rate	0 to 500 kHz				
Pulse Width	<25 ns @ 100 kHz				

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