FLEXIBLE DIE-CUT CIRCUITS (FDCS) HELP REDUCE THE COST OF CURRENT COLLECTOR ASSEMBLIES FOR EV BATTERIES

Electric vehicle manufacturers face several over-arching challenges regarding reducing overall costs for electric vehicles. This article focuses specifically on how a new innovative approach is helping eliminate between 25 and 50% of the cost for implementing electrical connections in EV battery systems.

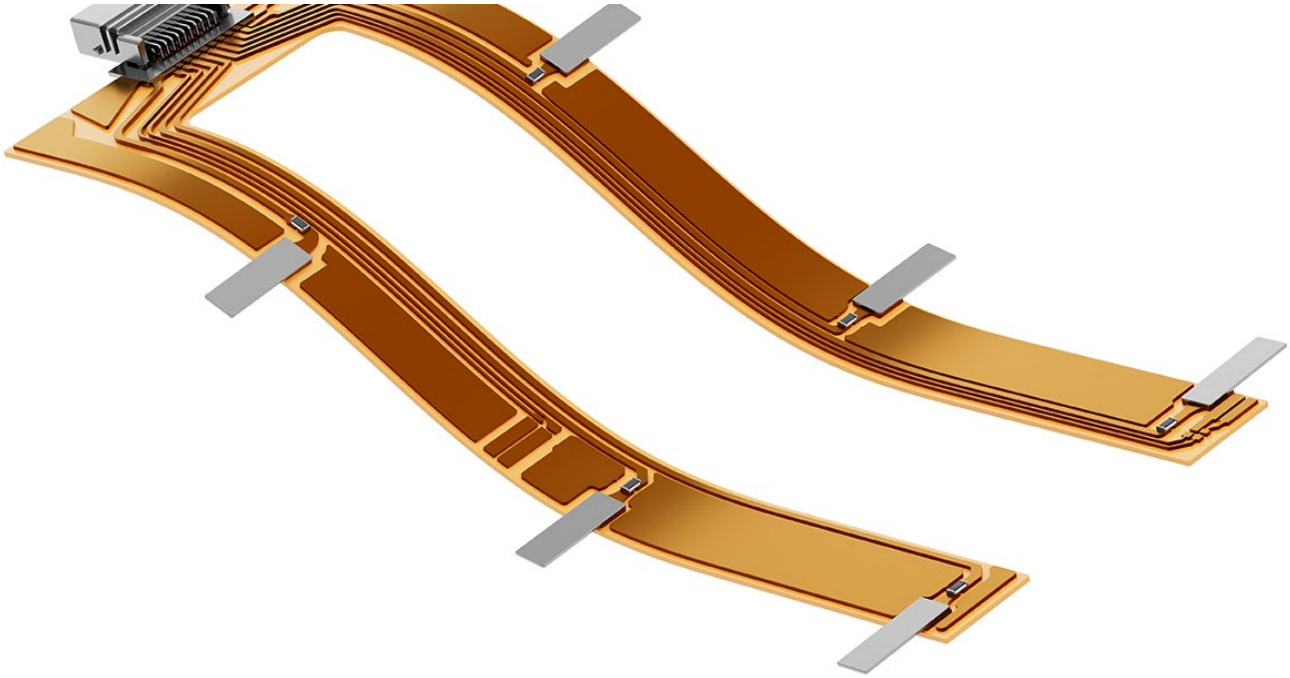

Figure 1 – Flexible Die-cut Circuit

The Need for Integrating Low-Voltage Circuitry to Manage EV Batteries

As shown below, copper flex circuits are used to interconnect current collectors to support monitoring of battery health and to interface with external battery management system (BMS) functionality. As EV batteries are increasing in both power density and complexity, these flex circuits provide a critical link to sense and manage thermal conditions, voltage levels, current flows, and potential hot spots.

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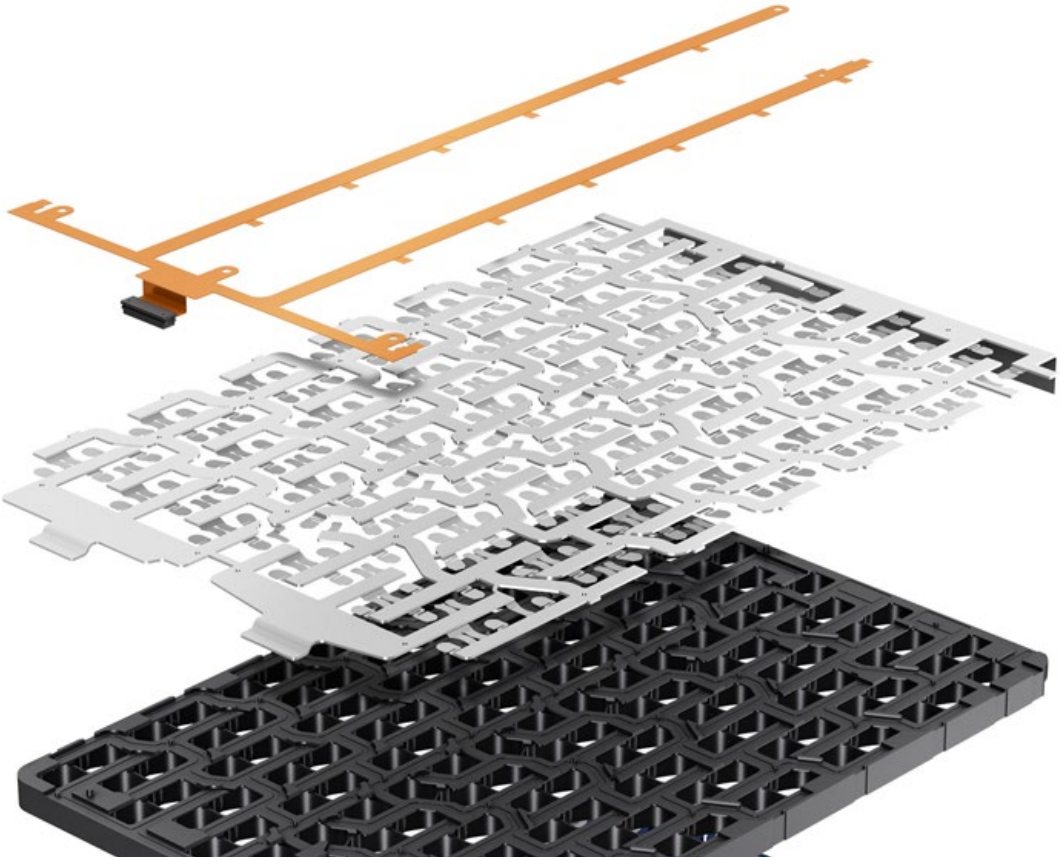

Figure 2 – Flex circuit on top of the current collector in a cell contacting system (CCS).

However, as discussed in the following section, conventional flexible printed circuits (FPCs) are typically the highest cost element in the current collector assembly and the innovative use of flexible die-cut circuits (FDCs) instead can provide significant cost reduction.

Comparison of Flex Printed Circuits (FPC) and Flex Die-Cut Circuits (FDC)

The key differences between the two types of flex circuits are the number of steps involved, the overall cost of production, and the closeness of pitch and spacing achievable by the processes.

Creating an FPC requires 12 steps in the process whereas creating an FDC only requires 9 steps and, even more importantly, the 3 FDC steps that are eliminated involving chemical etching, are the slowest and most costly. As shown in Figure 3, the final 6 steps along the bottom are essentially identical between the two approaches. But removing processes on the top line achieves more than just eliminating steps. Because the chemical etching process in FPC is batch oriented and requires dwell time during drying, exposure, and etching, it takes 2-3 days to complete, whereas the continuous precision die cutting process in FDC has no delays.

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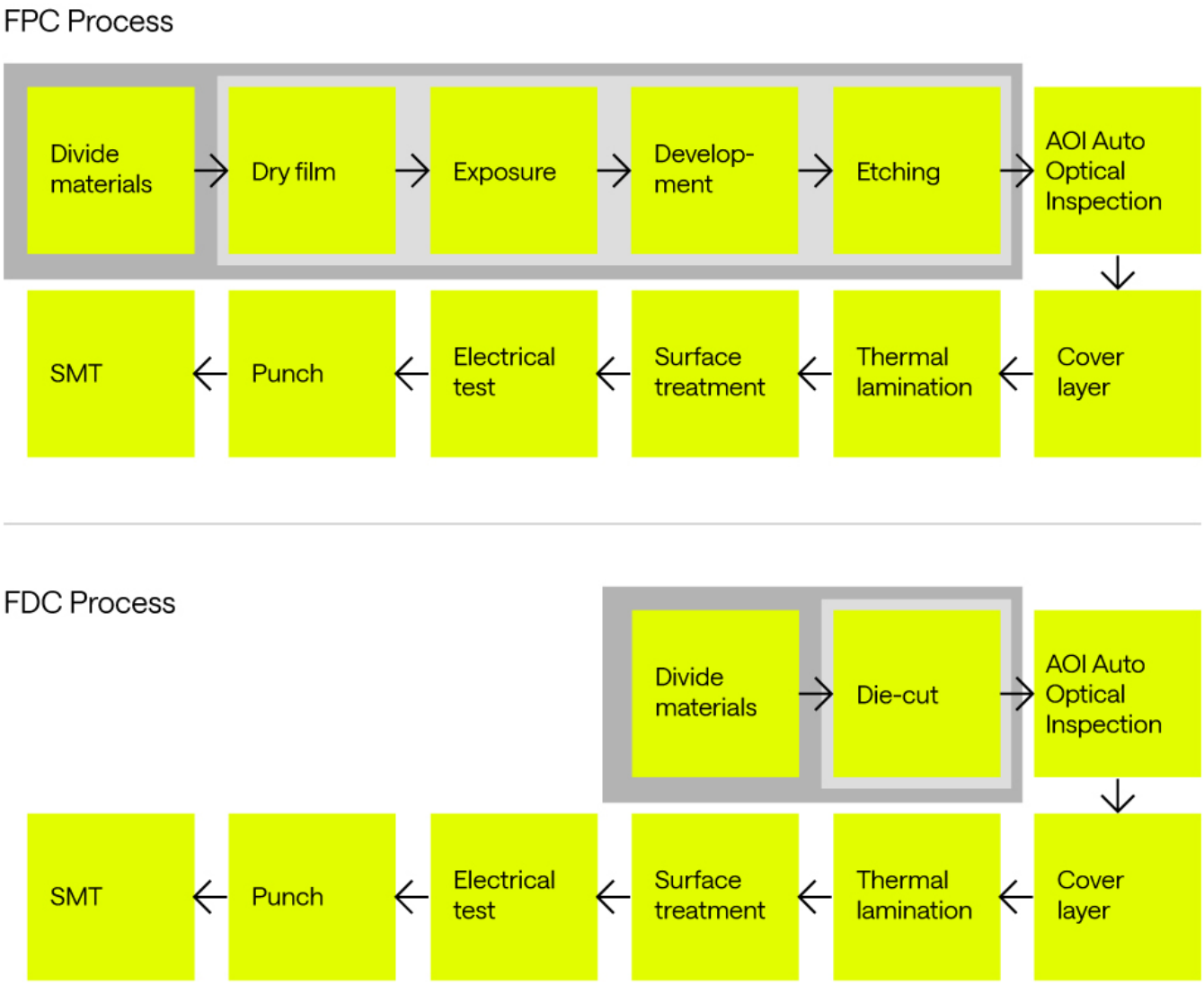

Figure 3 – Comparison of FPC and FDC processes

As shown in the table below, the primary difference in output is the ability of FPC chemical etching to produce tighter spacing and smaller traces as well as tighter turns in the traces. However, extensive studies of EV battery designs have shown that such tight spacing is not necessary to achieve EV battery design goals in most cases.

	FPC	**FDC**
Copper Layer	Chemically Etched	Die Cutting
Minimum Trace Width	0.25mm	0.35mm
Minimum Trace Pitch	0.30mm	0.35mm

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Laminate Layer	PI, PET, or PEN	PI, PET, or PEN
Cost	Higher	Lower
Cycle time	In batches	Continuous
Recyclability	NA	Yes

Sustainability, Simplicity, and Streamlined Logistics

In addition to faster processes and lower costs, there are other key benefits achieved from moving to an FDC approach, wherever the design specifications allow it.

SUSTAINABILITY – The FPC etching process destroys the copper being removed vs. the die-cutting process in FDC, which does not waste the copper being removed, leading to a more sustainable process.

SIMPLICITY – Elimination of chemical etching makes the overall process simpler and easier to manage for consistent quality results, thereby reducing the need for complex process control of the etching steps.

STREAMLINED LOGISTICS – With FPC, the flex printed circuit is typically a vendor-supplied item that incurs shipping costs and potential for supply chain delays that impact production output. In the case of FDC, for a vertically integrated company like ENNOVI with over sixty years of precision cutting experience, the entire process can be handled in a single facility.

Vertical integration also enhances the co-development process with our OEM customers because all prototyping and design modifications to FDCs can be handled quickly in-house without waiting for an FPC supplier to etch and process new flex circuits and to ship them for evaluation.

Summary

The bottom line is that, with EV design moving into the next phase where cost reduction, battery power densities and sustainability will be more important than ever, ENNOVI recognizes that every opportunity to remove costs and streamline output needs to be closely evaluated.

This commitment to innovation excellence has made ENNOVI a leader in new breakthrough technologies that span the full range of “large” and “small” innovations. Creating a faster and less expensive way to interconnect current collectors with Flex Die-Cut Circuits is one of many seemingly small innovations that can have major cost saving improvements over the long run.

Want to learn more? **Discover ENNOVI’s FDC technology.**

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