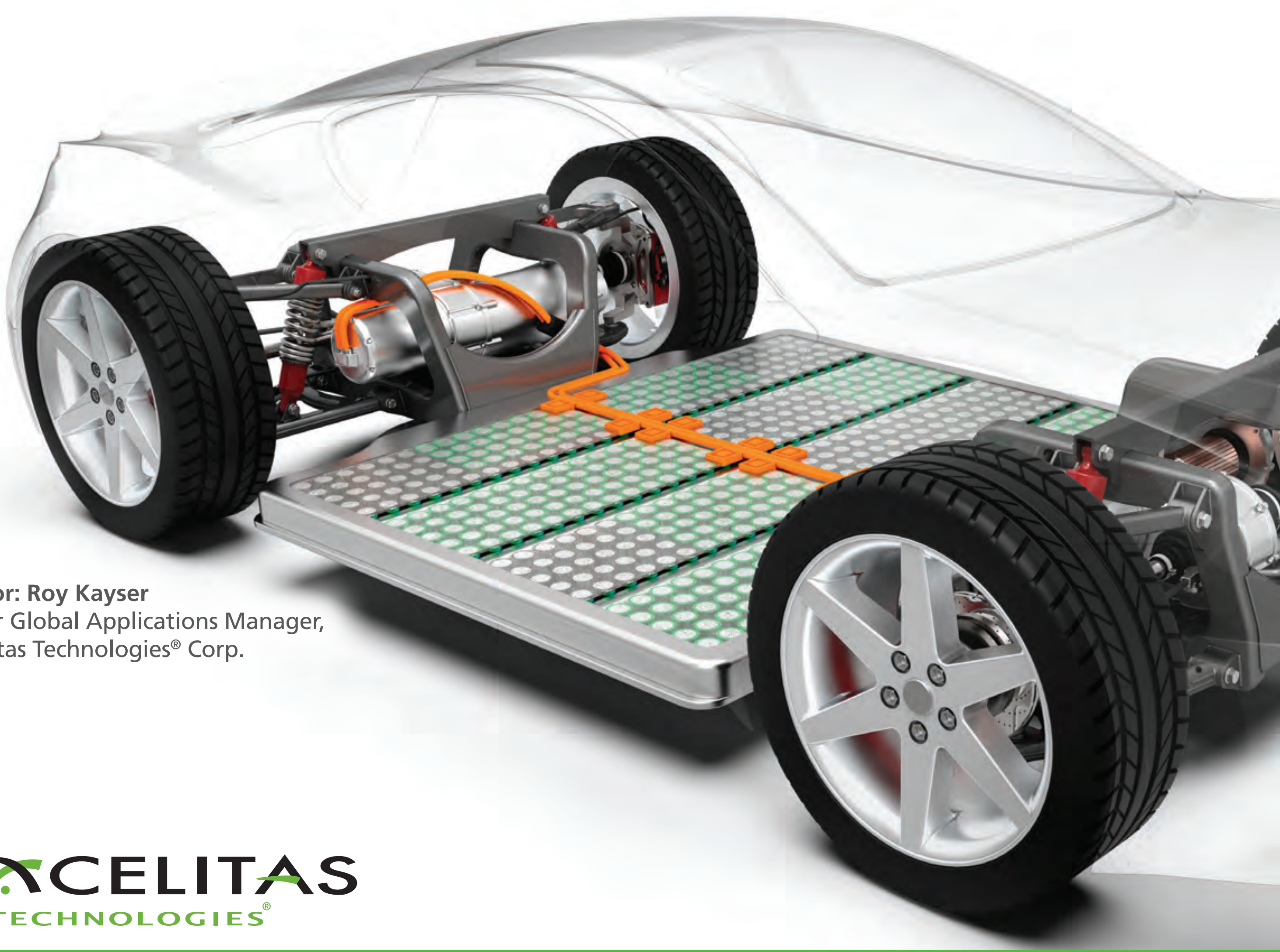
OmniCure®
UV Curing • In Control

Using UV Curing to Improve EV Battery Manufacturing Reliability and Costs

Application Overview

The International Energy Agency (IEA) reports global electric vehicle sales have grown from less than 25,000 in 2012 to greater than 8.5 million in 2021.[1] This tremendous growth in electric vehicles over the last 10 years has created many new opportunities for a variety of industries, including UV curable materials and processes. The need to continually improve manufacturing processes will be key to meeting the demand. The availability and breadth of UV curable materials have enabled them to be successful in multiple applications related to electric vehicles, including electric vehicle (EV) batteries, LIB pouch cells, fuel cells, coin cells and other geometries and chemistries, such as Li-iron phosphate (LFP), Li-nickel cobalt aluminum oxide (NCA), and Li-nickel manganese cobalt (NMC). This application note provides an overview of UV curable materials used in the manufacturing process of electric vehicle batteries. Suppliers who are able to successfully integrate these materials into a repeatable process, which can meet tighter environmental regulations, will have a definite advantage in this growing market.



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The Challenge

One of the most critical and costly components in an electric vehicle is the lithium-ion battery pack (LIB). Battery prices have dropped from $1200 per kWh in 2010 to as low as $101-132 per kWh in 2021.[2] However, due to raw material demand and availability in the near term, prices are expected to rise – putting a premium on improving process efficiency. Reductions in manufacturing costs while increasing reliability are at the forefront of EV battery research. The most significant portion of an EV battery is electrode fabrication; more specifically the electrode coating (binder) which is traditionally accomplished with polyvinylidene fluoride (PVDF).

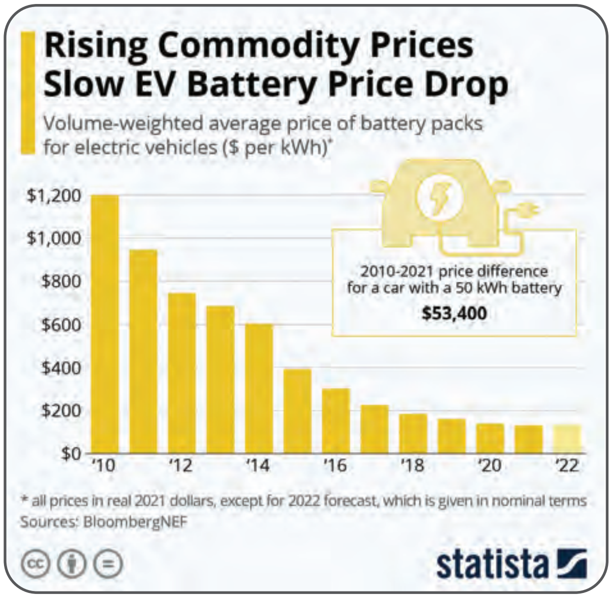
A second high profile EV battery manufacturing process covers the assembly of the individual cells into suitably sized battery packs. EV battery packs are subjected to environmental extremes; such as heat, corrosion, and vibration making their reliability a significant challenge for manufacturers. While most battery packs include elaborate thermal management systems, short-term thermal shocks and extreme vibration and shock levels continuously push the batteries to the limits of their endurance. Securement of individual cells as well as increasing the vibration resistance of the cell-to-cell welds (used for electrical connectivity) demands a better class of UV curable materials.

The Solution

Assembly of electrodes requires a precise application of coatings that facilitate the movement of lithium-ions between the anode and cathode. Traditionally PVDF material is used, however the application and drying process is very time consuming with high energy demands from the heated air dryer (>35,000 kW), solvent recovery (>1700 kW), solvent evaporation (>100 kW) and less than ideal yields. For these reasons the electrodes account for 63% of a battery cell cost (51% for the cathode electrode; 12% for the anode). A new generation of UV curable binders has been developed which completely negate the need for industrial dryers and solvents. These UV curable binders combined with new electrode coating processes using lower energy UV LED curing systems are purported to reduce manufacturing costs by as much as 80% resulting in reduced electrode costs of greater than 25%.

As UV curable binder materials are continuously evolving, some companies have identified a series of suitable oligomers, monomers and photoinitiators to be used in the formulation of UV curable binders. These binders have been used to successfully produce UV coated electrodes for batteries based on NMC111, NMC632, NMC811, and NMC532 electrode materials in addition to many other types. This technology is in the early stages of adoption and as such, off-the-shelf solutions are on the horizon with custom formulations readily available.

Battery pack assembly involves several steps of which two critical areas, cell retention and vibration control, are accomplished using a variety of materials. Switching to UV curable materials reduces VOC generation, speeds up assembly time, reduces assembly costs and improves reliability. To this end, many UV curable adhesive manufacturers are focusing on adhesives for the demanding environment that EV batteries find themselves operating within. These adhesives must meet strict automotive standards that include temperature extremes, high humidity, thermal shock and extreme vibration levels. Panacol, Dymax and Loctite are a small example of manufacturers that have reformulated or released new adhesives targeting EV battery assembly that can withstand this extreme environment.



Examples of lithium-ion battery assembly compatible UV curable adhesives and coatings

Application	Part Number	Compatibility	Manufacturer	Notes
LIB sealant/gasket	EA6062	OmniCure AC8/9 Series S2000 Elite LX500 UVA, 365nm	H.B. Fuller	In-place gasket forming and/or sealing of cells and battery packs.
LIB assembly	9501-F	OmniCure AC8/9 Series S2000 Elite LX500 UVA, UVV	Dymax	Cell assembly.
LIB assembly	AA 3963	OmniCure AC8/9 Series S2000 Elite LX500 UVA, UVV	Loctite	Cell assembly. Often used with Bayblend FR3040EV carrier.
Vibration resistance	Vitralit 2113	OmniCure AC8/9 Series S2000 Elite LX500 UVA, 365nm, 405nm	Panacol	Cell-to-weld protection. Low ion content.
Vibration resistance	Vitralit 2114	OmniCure AC8/9 Series S2000 Elite LX500 UVA, 365nm, 405nm	Panacol	Cell-to-weld protection. Low ion content.
Vibration resistance	Vitralit UD 8050	OmniCure AC8/9 Series S2000 Elite LX500 UVA, 365nm, 405nm Secondary humidity cure	Panacol	Cell-to-weld protection. Dual cure for shadowed areas. Ion-pur.

Top 10 EV (Cell) Battery Manufacturers[3]

Rank	Company	2021 Market Share	Country
#1	CATL	32.50%	China
#2	LG Energy Solution	21.50%	Korea
#3	Panasonic	14.70%	Japan
#4	BYD	6.90%	China
#5	Samsung SDI	5.40%	Korea
#6	SK Innovation	5.10%	Korea
#7	CALB	2.70%	China
#8	AESC	2.00%	Japan
#9	Guoxuan	2.00%	China
#10	PEVE	1.30%	Japan
NA	Other	6.10%	Various
NA	Stellantis	NA	Canada

Other sources (i.e. IEEE Spectrum) have a slightly different list of the top 10 EV battery manufacturers and rank Gotion High-Tech at position 8 and Ruipu Energy at position 10.[4]

Currently the top 10 EV battery manufacturers are located in Asia, however recently a major agreement was reached with local and federal governments to open an EV battery manufacturing facility in Windsor, Ontario. This factory will be fully functional in 2025 and will boast a capacity of 35 gigawatt hours.

Advantages of the OmniCure® AC8 and AC9 UV Curing Systems

The OmniCure AC8 and AC9 UV Curing Systems are available in a variety of sizes and standard wavelengths (365nm, 385nm, 395nm and 405nm) as well as customized alternative wavelengths including 275nm, 340nm and 420nm. Selecting the ideal OmniCure system for a particular application and adhesive will depend upon the specific type and volume of adhesive or coating, substrate size, and optical transparity (to UV).

Once properly selected, the OmniCure AC8 and AC9 Curing Systems will provide:

- Reduced process times, higher throughput with lowered rejection rates
- Enhanced reliability of battery packs, ultimately reducing cost of manufacturing
- Lower operational costs and resource consumption
- Environmentally friendly with reduction or elimination of VOC's

References

[1] Global EV Outlook 2021 (https://www.iea.org/reports/global-ev-outlook-2021)
[2] Breaking Down the Cost of an EV Battery Cell (https://elements.visualcapitalist.com/breaking-down-the-cost-of-an-ev-battery-cell)
[3] Ranked: The Top 10 EV Battery Manufacturers (https://elements.visualcapitalist.com/ranked-top-10-ev-battery-makers)
[4] The Top 10 EV Battery Makers (https://spectrum.ieee.org/the-top-10-ev-battery-makers)

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