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Engineering Plastics Solutions in Lithium-Ion Battery

XYRON™ modified polyphenylene ether [mPPE]

**Electrical**
- Excellent electrical property especially for electrical applications

**Thermal**
- Wide thermal resistance ranging up to 200 °C

**Flammability**
- PPE default V-2 rated.
- High flammability class of V-0 and 5VA.
- Non-Halogen

**Mechanical**
- Mechanical properties with lowest density.
- No Hydrolysis which compromise on mechanical properties.

**Chemical resistance**
- Excellent chemicals resistance in Lithium-Ion Battery especially PP/PPE.

**Moldability**
- Dimension stability and accuracy can easily achieve

---

**Battery casing**
- Excellent electrical insulation.
- Protection against drop impact.
  - Mechanical drop test – AIS 156
  - Mechanical Shock – AIS 156
  - Thermal shock & Cycling – AIS 156

**Cell holders**
- Low warpage and excellent dimension stability.
- Chemical resistance to lithium-ion chemistry.
- Stable mechanical properties.
  - Vibration test – AIS 156

**Busbar cover**
- High electrical insulation.
- Design flexibility.
- V-0 flammability class.
Category wise Electric Vehicle sales, Oct 2022

Total Registered Electric Vehicle Sales - **Oct 22 - 1,16,651** | **Sep 22 - 93,601**

<table>
<thead>
<tr>
<th>Category</th>
<th>Oct-22</th>
<th>Sep-22</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-2 Wheeler</td>
<td>52,978</td>
<td></td>
</tr>
<tr>
<td>E-3 Wheeler Cargo</td>
<td>31,835</td>
<td></td>
</tr>
<tr>
<td>E-3 Wheeler Passenger</td>
<td>33,454</td>
<td></td>
</tr>
<tr>
<td>E-4 Wheeler</td>
<td>2,959</td>
<td>2,686</td>
</tr>
<tr>
<td>E-Bus</td>
<td>241</td>
<td>204</td>
</tr>
</tbody>
</table>

8,63,861 EVs sold in last 12 months - from Nov 2021 to Oct 2022

**Source:** Vahan Dashboard. Data as per 1340 out of 1412 RTOs. Low speed e-2Ws not included.
Fuel wise 2W Sales Trend, Oct 2021 - Oct 2022

High Speed E-2W Sales Trend by OEM

Source: Vahan Dashboard. Data as per 1340 out of 1412 RTOs. Note: Low speed Electric 2 Wheelers data is not included
3W Passenger Sales Trend by Fuel Type, Oct 2021 - Oct 2022

Source: Vahan Dashboard. Data as per 1340 out of 1412 RTOs. The aim of these graphs is to represent an overall trend of the new EV registrations in India.
For E-3W Passenger and Cargo vehicles, the top 10 OEMs contributed only 46% and 44% of the sales, respectively, in October 2022.

Source: Vahan Dashboard. Data as per 1340 out of 1412 RTOs.
## OEM wise E-4Wheeler Sales Oct 2022

<table>
<thead>
<tr>
<th>S.No.</th>
<th>OEMs</th>
<th>Oct-22</th>
<th>Sep-22</th>
<th>Difference</th>
<th>% Change</th>
<th>OCT 2022 Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TATA MOTORS</td>
<td>4277</td>
<td>3655</td>
<td>622</td>
<td>17.02%</td>
<td>86.67%</td>
</tr>
<tr>
<td>2</td>
<td>MG MOTORS</td>
<td>450</td>
<td>286</td>
<td>164</td>
<td>57.34%</td>
<td>9.12%</td>
</tr>
<tr>
<td>3</td>
<td>HYUNDAI MOTORS</td>
<td>82</td>
<td>75</td>
<td>7</td>
<td>9.33%</td>
<td>1.66%</td>
</tr>
<tr>
<td>4</td>
<td>BYD INDIA</td>
<td>36</td>
<td>65</td>
<td>-29</td>
<td>-44.62%</td>
<td>0.73%</td>
</tr>
<tr>
<td>5</td>
<td>KIA MOTORS</td>
<td>33</td>
<td>0</td>
<td>33</td>
<td>-</td>
<td>0.67%</td>
</tr>
<tr>
<td>6</td>
<td>MERCEDES-BENZ</td>
<td>23</td>
<td>3</td>
<td>20</td>
<td>666.67%</td>
<td>0.47%</td>
</tr>
<tr>
<td>7</td>
<td>MAHINDRA &amp; MAHINDRA</td>
<td>15</td>
<td>112</td>
<td>-97</td>
<td>-86.61%</td>
<td>0.30%</td>
</tr>
<tr>
<td>8</td>
<td>BMW</td>
<td>6</td>
<td>28</td>
<td>-22</td>
<td>-78.57%</td>
<td>0.12%</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>13</td>
<td>28</td>
<td>-15</td>
<td>-53.57%</td>
<td>0.26%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>4,935</td>
<td>4,252</td>
<td>683</td>
<td>-2.44%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

## OEM wise Electric Bus Sales, Oct 2022

<table>
<thead>
<tr>
<th>S No</th>
<th>OEMs</th>
<th>Oct-22</th>
<th>Sep-22</th>
<th>Difference</th>
<th>% Change</th>
<th>Oct-22 Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PMI ELECTRO MOBILITY</td>
<td>96</td>
<td>48</td>
<td>48</td>
<td>100.00%</td>
<td>39.83%</td>
</tr>
<tr>
<td>2</td>
<td>SWITCH MOBILITY</td>
<td>59</td>
<td>79</td>
<td>-20</td>
<td>-25.32%</td>
<td>24.48%</td>
</tr>
<tr>
<td>3</td>
<td>VE COMMERCIAL VEHICLES</td>
<td>29</td>
<td>6</td>
<td>23</td>
<td>383.33%</td>
<td>12.03%</td>
</tr>
<tr>
<td>4</td>
<td>JBM AUTO</td>
<td>24</td>
<td>16</td>
<td>8</td>
<td>50.00%</td>
<td>9.96%</td>
</tr>
<tr>
<td>5</td>
<td>ELECTRA GREENTECH</td>
<td>21</td>
<td>49</td>
<td>-28</td>
<td>-57.14%</td>
<td>8.71%</td>
</tr>
<tr>
<td>6</td>
<td>MYTRAH MOBILITY</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>100.00%</td>
<td>4.98%</td>
</tr>
<tr>
<td>7</td>
<td>ASHOK LEYLAND</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>0.00%</td>
</tr>
<tr>
<td>8</td>
<td>TATA MOTORS</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>241</td>
<td>204</td>
<td>37</td>
<td>18.14%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Source: Vahan Dashboard. Data as per 1340 out of 1412 RTOs. Official press releases. The aim of these graphs is to represent an overall trend of the new EV registrations in India.
Collation of relevant information on the evolving electric vehicle landscape in Singapore
EV category-wise sales trend for last 5 quarters

Category wise EV sales in Q2 FY 22-23 (JULY 2022 to SEP 2022)

Source: Vahan Dashboard, Telangana Transport portal and EVreporter Research. Low-speed 2W data not included.
The total number of Electric vehicles sold in India in the last 4 quarters from Q3 FY 21-22 to Q2 FY 22-23 comes out to be 8,32,360 units.

EV sales registered a Y-o-Y growth rate of 188% between the second quarter of FY 21-22 (95,425 units) and the second quarter of FY 22-23 (2,74,705 units).

Electric vehicle sales are dominated by 2-Wheelers and 3-Wheelers, with a combined volume share of almost 92% for Q2 FY 22-23. Electric 2-Wheeler sales for Q2 FY 22-23 witnessed a Q-o-Q growth of 16% with 1,62,215 units sold, whereas the Electric 3-Wheeler sales registered a Q-o-Q growth of 41% with 89,726 units.

Electric vehicles region-wise sales trend

**Trend in Top 10 Indian States from JULY 2022 to SEP 2022 (Q2 FY 22-23)**

<table>
<thead>
<tr>
<th>STATE</th>
<th>EVs Sold</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uttar Pradesh</td>
<td>47334</td>
<td>17.23%</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>33671</td>
<td>12.26%</td>
</tr>
<tr>
<td>Karnataka</td>
<td>23106</td>
<td>8.41%</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>20416</td>
<td>7.43%</td>
</tr>
<tr>
<td>Telangana</td>
<td>17864</td>
<td>6.50%</td>
</tr>
<tr>
<td>Gujarat</td>
<td>17393</td>
<td>6.33%</td>
</tr>
<tr>
<td>Bihar</td>
<td>16525</td>
<td>6.02%</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>15983</td>
<td>5.82%</td>
</tr>
<tr>
<td>Delhi</td>
<td>14992</td>
<td>5.46%</td>
</tr>
<tr>
<td>Assam</td>
<td>10950</td>
<td>3.99%</td>
</tr>
<tr>
<td>All Other States</td>
<td>56471</td>
<td>20.56%</td>
</tr>
</tbody>
</table>

*Source: Vahan Dashboard, Telangana Transport. Low-speed 2W data not included.*

- Uttar Pradesh has the highest share (17.23%) of EV sales in the quarter. Of the total EVs sold in Uttar Pradesh, 84% (39,667 units) are L3M category or e-rickshaws.
- E-2W sales are maximum for Maharashtra, Karnataka, Gujarat, Tamil Nadu and Telangana, with a combined share of 59% and more than 10,000 units each.
- Maharashtra has the highest sales of E-4W with 3,030 units (23%) for Q2 FY 22-23.
The cumulative sales of the top five OEMs in Q2 FY 22-23 account for 71% (1,02,786 units) of the overall sales. Hero Electric dominated the market with a 19% share in Q2 FY 22-23, followed by Okinawa Autotech with a 17% share.
New technology will aid in performance testing and appraisal of used-car value

Hioki Develops Technology for Measuring Batteries Directly from EVs’ Rapid-charging Connectors

Hioki is pleased to announce that it has developed technology for connecting a dedicated instrument to the rapid-charging connectors on EVs and PHEVs to measure the characteristics of vehicle battery packs. The technology makes it possible to directly measure battery pack characteristics and ascertain the battery’s condition based on the results.

Development Background

Hioki supplies a wide range of testing equipment for use in lithium-ion battery (LIB) cell, module, and pack manufacturing processes. A number of products, particularly impedance instruments (battery testers) have become de facto standards in the industry, and Hioki has played a leading role in quality testing in the industry since the earliest days of LIB commercialization. More recently, the company has been developing testing technologies not only for manufacturing processes and new-product testing, but also for evaluating degraded LIBs during and after use.

However, information related to the condition of the battery packs used in EVs is generally managed by an onboard controller, making it difficult for third parties to test battery condition. Although third parties can access LIB-related information transmitted on vehicle networks like CAN buses and use that data for diagnostic purposes, the fact that such data is acquired by the EV itself means that the diagnostic process cannot be accomplished entirely by third-party means.

The transition to electric vehicles has been gathering momentum worldwide. To realize an economic growth strategy founded on decarbonization, it is not enough to merely adopt LIBs as a power source for automobiles; it will also be essential to streamline resource recycling systems and establish an appropriate value chain. Assessing the performance of the EV battery packs will be a key part of building the LIB value chain. As a result, there’s a need for technology that can be used by third parties to test the condition of battery packs for the purpose of evaluating EV performance, appraising used EVs, and managing automotive fleets.*

In response to this situation, Hioki drew on impedance measurement technology developed over many years to develop a solution that makes it easy to measure battery pack characteristics via the rapid-charging connectors on EVs and PHEVs.

Principal applications

- Diagnosing the performance of and appraising used EVs
- Testing battery pack condition during EV maintenance
- Testing the condition of battery packs to facilitate efficient EV fleet management

*Fleet management: The process of managing fleets of company- and business-use vehicles operated by businesses and other organizations.
RattanIndia Enterprises Limited is acquiring 100% shareholding in the electric motorcycle company Revolt Motors. RattanIndia had earlier acquired a 33.84% shareholding in Revolt. Revolt Motors currently has a manufacturing facility in Manesar and 29 dealerships across India. Revolt bikes run on 3.24 kWh lithium-ion batteries and can attain a top speed of 85 km/hr and provide a range of 150 km.

New Delhi-based EV solutions company Vecmocon Technologies raised USD 5.2 million in pre-series A round led by Tiger Global Management and Blume Ventures. It provides solutions like motor controllers, BMS, instrument cluster and Vehicle Intelligence Module for electric vehicles.

Pune-based electric bicycle maker EMotorad raised INR 24 crore in a Pre Series A round, led by Green Frontier Capital (GFC) and Ivy Growth Associates.

EV-based delivery solutions provider MoEVing has raised $2.5 million from JSW Ventures. The current fundraising takes its entire funding to $10 million. Founded in 2021, MoEVing has an operational presence in 15 cities. The start-up operates 1,500 electric vehicles, including 2-wheelers and 3-wheelers. The investment by JSW Ventures is their first one in the electric vehicles space.

EV financing company Mufin Green Finance has raised $5.7 million in series A funding round led by Incofin India Progress Fund (IPF). The company plans to disburse income-generating loans worth INR 5,000 crore in the next 5 years.

EV financing company Revfin raised $10 million in a mix of equity and debt financing series, a round from Green Frontier Capital and LC Nueva Investment Partners, among others. The company aims to expand its footprint to 25 states and finance at least 10% of EV purchases in the next five years.

EV powertrain solutions company Electra EV has raised over $25 million from GEF Capital Partners’ South Asia Growth Fund II. Electra EV will use the capital to expand the product portfolio across e-3Ws, e-4Ws, agricultural applications, and other EV segments to serve domestic and international OEMs and tier-1 suppliers.

Ahmedabad-based EV charger manufacturer Tirex Transmission announced funding of $2 million from an HNI investor, says a report by Entrepreneur.com.

Epsilon Advanced Materials signed an MoU with the Government of Karnataka to invest INR 9,000 crore to establish graphite anode plants in the state over the span of 10 years. The Government of Karnataka would facilitate the company in obtaining necessary registrations and clearances. Notably, more than 90% of graphite anodes are manufactured in China today.
A VISIT TO JENDAMARK PUNE FACILITY

The EVreporter team had a chance to visit Jendamark India's Pune facility in Oct 2022. The visit helped us take a closer look at the processes and automation services the company offers for the electric vehicle industry.

Overview

In 2014, South Africa-based Jendamark Automation entered India, bringing to the table its 30+ years of operating across the world. The group acquired a manufacturing firm in India, and Jendamark India made the transition right from pure manufacturing to conceptualizing, designing, programming and taking overall responsibility as a turnkey solution provider for the automotive industry.

Over the years, Jendamark India has established business relationships with the likes of Mahindra, Hero, Sharda Motors, Dana, Skoda, Ashok Leyland, Kalyani Technoforge and others. Its main premises is located in the industrial suburb of South Pune. The company's current strength is 270 employees, with offices also in Chennai and Bangalore.

Jendamark offers complete turnkey solutions in the following five different business verticals - Powertrain, Catalytic Converter Assembly Lines, Electric Vehicle Assembly Line, Aerospace Tooling and Digital Services.

- The company provides comprehensive solutions right from concept design, manufacturing, assembly, programming and after-sales services.

- Jendamark works on the principle - 'In an assembly line, whatever touches the customer part needs to be manufactured in-house in order to ensure the confidentiality and quality of the product'.

Jendamark India has an in-house manufacturing unit, where most of the parts get manufactured.
Jendamark has both automation and IT experts working together to deliver assembly solutions to the automotive industry. The company offers a blend of automation and digital services, providing customers with accurate data and accurate reports at their fingertips, along with operator guidance which plays a huge role in any production line.

**EV solutions and Industry 4.0 automation services**

At present, Jendamark India is providing customised, indigenously developed assembly line and testing solutions to several electric vehicle manufacturers.

**These solutions range from component-level lines for battery packs, motors, rotors, transmissions and MCU to solutions for vehicle-level assembly.**

All solutions are equipped with an in-house developed Industry 4.0 platform - ODIN ecosystem, which helps improve operator efficiency, production rates & data traceability.

During our visit, Team Jendamark demonstrated a factory tour at its ODIN Experience Centre featuring the assembly of traction motors and EV battery packs for electric 2Ws and 3Ws, followed by an exclusive interaction with CEO Himanshu Jadhav.

**Tour of EV assembly line solutions at Jendamark**

**Electric motor assembly line**

**Jendamark's e-motor assembly line** covers an area of approximately 12,000 square feet.

There are 16 stations throughout the line layout, divided into two sub-assembly lines arranged parallel to each other, **capable of producing an electric motor every 4 minutes.**

All assembly steps are rigorously checked with operator guidance. **The critical parts are scanned by the ODIN system at each station, which helps ensure traceability even at a sub-component level.**
Battery pack assembly line

The battery pack assembly line is located in assembly hall no. 2 of similar size as the motor assembly line, with an annual capacity of 50,000 battery packs (two shifts working).

The assembly line consists of 26 station points divided into two sub-assembly lines.

- First line starts with laser marking of cells, cell sorting, polarity checking and spot welding.

- The second line includes processes of battery management system (BMS) installation, thermal pasting and quality testing key parameters of BMS testing, leak testing, and monitoring and verification of all torque applications.

High currents and voltages in battery cells, modules and packs require automated assembly and safer material handling.

The ODIN system guides through every station and step, eliminating human error and intervention.

More about ODIN Ecosystem

ODIN Ecosystem includes various digital services like ODIN Manufacturing, ODIN Maintenance, ODIN Ensure, ODIN Documentation and a lot more. Jendamark’s human-centric approach helps to provide their customers with a solution suitable to their requirements considering the current industry environment, while increasing operator efficiency, production rate and data traceability.

In order to help its customers get a hands-on experience of the assembly line prior to the execution stage, Jendamark does design approvals using Virtual Reality and Augmented Reality. This helps the customers develop a clear understanding of what has been designed, and if changes are needed in layout or ergonomics, they can be made in the early stages.

Enquiries

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**UNDERSTANDING DEAL-MAKING IN ELECTRIC VEHICLE SPACE**

*A chat with Koushik Bhattacharyya, Executive Director and Head, Industrials Investment Banking, Avendus Capital*

Avendus Capital is a financial services firm based in Mumbai with a dedicated practice focusing on electric vehicles (EVs) and industrial space. The practice is led by Koushik Bhattacharyya, who believes that the Indian Electric Vehicle ecosystem collectively represents a **60-billion-dollar opportunity by 2030**. Below are the excerpts from a recent conversation with Koushik about deal-making in the EV space.

**Please tell us about some of the recent fundraising deals you helped execute in the electric vehicle space.**

There are a couple of deals that we have closed in the last year and a half.

- One is a **USD 60 million** deal for the leading electric commercial vehicle manufacturer Euler Motors, led by GIC. Euler is currently manufacturing three-wheelers and graduating to four-wheelers, which will be launched over the next few months.

- The other deal we did last year was a **USD 30 million raise for the electric 2W company Hero Electric**.

We are running a few other deals which are in various stages of finalisation. These deals are being pursued across the EV ecosystem with companies ranging from battery technology to OEMs to e-mobility-as-a-service providers.

**Within EV domain, which business lines do you find more active than the others?**

The most active segment with respect to fundraising is the **OEM category**, where people manufacture vehicles and sell them to end customers. That is the most well-understood part of the ecosystem because it is consumer-facing, brands play a role, and one can understand the product well. Also, it is easier for investors to compare the EV OEM space to the internal combustion engine (ICE) OEM market and predict future outcomes vis-a-vis some other parts of the EV ecosystem where there is no direct comparison in the ICE industry. Hence, you see more action in the OEM Space.

**As an investment banker, how do you see the current EV ecosystem? What kind of potential does the sector have?**

I think the potential is humongous. Look at the two-wheeler segment. In the last 2 years, the monthly sales have gone up from nearly 10,000 to 60,000+ units. In many of the vehicle categories, including two-wheelers, and small commercial vehicles, **we expect EV penetration to exceed 50% over the next five to seven years.**
I think there are two important levers which are slightly under-penetrated today, and once they come up the curve, the adoption can accelerate even more. One is financing - it's important as the upfront cost typically becomes a barrier for the consumer. Financiers today have very limited data and conviction about EVs as, in most vehicular categories, vehicles have not passed their full life cycle, which is a four to five-year journey. I am hopeful that financing will kick in meaningfully in the next 12 to 18 months. For some of the bigger vehicular categories, charging infrastructure is also a necessity. It is a mental block for the first-time buyer more than a real problem. However, in order to remove that, we'll need to set up some bit of charging infrastructure.

**What are investors looking for while evaluating EV start-ups? What are the main factors at play here?**

The three most important things that investors are looking at are:

- **Scalability**: Scalability is a function of two things - the total addressable market (TAM) that you are targeting and the scalability of your business model.

- **Differentiation**: What gives you the right to win in a market? If you are a 2W OEM, what stops an incumbent ICE OEM who knows the distribution game from beating you? What stops the leading new-age EV companies with a great product and perception in the market from beating you?

- **Path to profitability**: A vast majority of the business models in the EV space today are negative margin businesses. **Investors want to look at the unit economics and how you plan to be profitable eventually over a three to five-year horizon.**

**How do you figure out the synergies between EV companies looking to raise funds and potential investors?**

Most investors have started looking at this space in the last 12 to 24 months and are still trying to freeze their investment thesis on electric vehicles. You must go to a wider set of guys than in the case of a mature, steady-state business. There are certain categories of investors for whom e-mobility start-ups are a great fit.

- The first category would be **sovereigns**, as they are focused on long-term impact and value creation and have social impact built into their investment thesis.

- The second is a category of **DFIs** (Development Finance Institutions), which also want to deploy different forms of capital, including debt.

- The third category, especially for early-stage start-ups, is **VCs** (Venture Capitalists). VCs look at outsized outcomes, and their outcome parameters are very different from a growth-oriented private equity fund.
EV is the kind of market where one can make that kind of value by backing the right entrepreneurs and the right business model. So, VCs are taking a lot of bets in the early stages across the value chain to play the overall EV story.

So, there are three kinds of investors who are more active at different stages, VCs in the early stages, DFIs in the Middle stages and then sovereigns in the late stages. Increasingly, the bulge bracket private equity funds are creating an impact pool. Well-known names like TPG, KKR or General Atlantic are creating pools from where they can make smaller targeted ESG investments aimed at creating impact.

Please tell us about your valuation approach for EV start-ups.

As I mentioned, most of the business models today are in a state of evolution and not profitable. Valuation is typically based on the revenues, either current or forward-looking, and a multiple is placed on that number. Typically, we look at forward-looking revenue like a 12-month forward revenue or a projected annualized revenue run rate (ARR), six months down the line and then place a multiple based on the business model.

How do you perform risk assessment when evaluating an EV start-up?

Risk assessment dovetails into those metrics I spoke about. I think TAM is less relevant from a risk standpoint, while differentiation and path to profitability are more important. Investors spend a lot of time understanding whether the model is truly differentiated or not. The path to profitability is strongly correlated with risk. We assess how easy or difficult it is for a business to raise capital frequently enough to sustain the burn in the business. So even if the business model is very differentiated, but the path to profitability is a long way out, and you cannot raise external capital to sustain that kind of loss - it is challenging to raise the capital.

With the wave of new EV companies coming up, do you see consolidation happening in the market, in, say 2-3 years’ time?

I think there will be consolidation, but two-three years is probably a short time to expect large M&A activities. Some bit of M&A has already started happening with business groups, who wanted to make a foray, buying small 2W OEMs or BMS companies etc., but these are sub USD 50-million acquisitions mostly. Consolidation with larger businesses being acquired by even bigger groups will take some time. Some of these successful companies are being run by very competent entrepreneurs, they would want to grow their business to a certain level till the time they see the unhindered growth curve. At some logical point when they think that at least 80% of their journey is traversed, they might look at exit options for their investors and for themselves.

You could still see some start-ups failing to scale up and hence selling out, but that would probably fall in the small ticket acquisition bucket. People will make very opportunistic deals to get a place on the table. But the larger ticket deals will start happening five years down the line.
Quality Assurance for Battery Trays

The battery tray is a core component that serves as the interface between the drive and the car body. For manufacturers and material suppliers, it presents a number of complex design challenges. The battery system must be crash-proof, leak-proof, corrosion-resistant, electromagnetically shielded, and cooled. Five quality gates need to be mastered so as to guarantee maximum vehicle safety and quality. See below for a brief overview of how ZEISS can support you in tackling these issues. Further details can be found in the comprehensive focus brochure entitled Battery Trays Deep Dive.

Quality gates and solutions:

**Inline Inspection**

- Joining Process Control
  - A variety of safety-related criteria must be met
  - Highly complex assembly process due to different component properties and welded joints
- Milling & Drilling Process Control
  - Compliance with short measuring cycles for significant features despite tough environmental conditions (e.g., dust and oil in the air or large temperature fluctuations)
- Full-Field Inspection
  - Evaluation of the complete surface to guarantee dimensional accuracy of the entire car body (inspection of flanges, mating surfaces, and sealing surfaces)
  - Flexible cables and connectors must be positioned correctly
  - Individual battery modules must fit properly in the battery tray

Quality gates and solutions:

**Online and Offline Analysis**

- Critical Functions Control
  - Inspection and logging of the entire battery tray to prevent corrosion and bending of the tray as a result of high temperatures
- Structural Analysis
  - Inspection inside material to identify defects and determine their size and position

Carl Zeiss India (Bangalore) Pvt. Ltd.  +91 80 4343 8102  info.metrology.in@zeiss.com  www.zeiss.co.in
Hero MotoCorp launched its first electric scooter called 'VIDA V1'. The company introduced two variants - VIDA V1 PRO and VIDA V1 PLUS, priced at **INR 1.59 lakh** and **INR 1.45 lakh**, respectively (including FAME II subsidy and portable charger). Both variants have a top speed of 80 kmph and a charging rate of 1.2 km/min.

V1 Pro claims an IDC range of 165 km and 0-40 kmph in 3.2 seconds, while the V1 Plus has a range of 143 km and can hit 0-40 kmph in 3.4 seconds. The scooter will be first launched in Delhi, Jaipur and Bangalore. Deliveries to start in December second week.

**Ola Electric has launched S1 Air** which weighs 99 kg, is lighter than S1 and S1 Pro, **priced at INR 84,999**.

It has a claimed range of 101 km in eco mode and a top speed of 85km/h in sports mode. Bookings are open, with deliveries expected to start in April 2023.

**Nashik-based e-2W company Kyte Energy** launched the High-Speed Magnum Pro, priced at **INR 80,999 Ex-Showroom**. Key features:

- Dual battery and dual charger
- NMC battery
- 0 - 40 km/hr in 6 seconds
- Top speed of 60 km/hr

**EV startup Baaz Bikes** launched its first electric scooter with swappable batteries at a price point of **INR 35,000** (ex-showroom, Delhi).

The company has also introduced a modular Li-ion Battery Pack, the **Baaz Energy Pods**, at IIT Delhi. The pack, built specifically for the gig delivery riders of India, will power all the Baaz Models and can also integrate with other electric scooters.

Electric sports motorcycle maker **Ultraviolette Automotive** hosted its first Battery Day event on 18 October 2022, where it announced an IDC **range of 300 km** for the top-end variant of the F77 motorcycle. F77 will come in 3 variants - Airstrike, Shadow and Laser. Pre-bookings open starting October 23, 2022.
Gogoro and Zypp Electric will launch a B2B battery swapping pilot for last-mile delivery fleets in Delhi in December 2022.

Gogoro expects to work with multiple fleet operators in India to support last-mile fulfilment, e-commerce, & hyper-local deliveries. Gogoro is also a founding member of the Indian Battery Swapping Association.

Gurugram-based EV battery swapping network Mooving and delivery platform Shadowfax signed an MoU to deploy 10,000 EVs in Shadowfax's fleet over the next 12-18 months. Mooving provides its battery-swapping powered vehicle subscription platform to Shadowfax riders.

Electric motorcycle manufacturer Tork Motors has delivered the first lot of electric motorcycles in Mumbai from its headquarters in Pune. Tork Motors launched KRATOS® and KRATOS®-R in January 2022. KRATOS® is priced at INR 1,22,499 [ex-showroom after subsidy in Maharashtra], while KRATOS®-R is priced at INR 1,37,499 [ex-showroom after subsidy in Maharashtra]. The OEM is backed by Bharat Forge.

TVS Motor Company's domestic two-wheeler sales were 275,934 units in October 2022, out of which 8,013 were electric. iQube Electric sold 8,103 units in October 2022 as against sales of 395 units in October 2021. The company sold 4,923 units of TVS iQube Electric in September 2022 as against sales of 766 units in September 2021.

A letter by the Ministry of Road Transport & Highways has requested the States/UTs to look into the violations of CMVR norms by OEMs in the sale of low-speed electric two wheelers.

The letter states that many dealer showrooms across India are indulged in the sale of battery-operated 2Ws in contravention of the provisions under CMVR 1989. These manufacturers and dealers are supplying higher battery capacity models, which are plying with top speeds of 40 kmph to 55 kmph without type approval, insurance and vehicle identification. These vehicles are also tampering with the verification undertaken by the Testing Agency.

Saera Electric Auto has entered into a contract manufacturing agreement with two-wheeler manufacturer Lohia Machines Limited (LML). LML is making its comeback into the Indian market with electric two-wheelers, which will be manufactured in the Saera Electric Plant in Bawal, Haryana, which has an annual production capacity of 2,00,000 e-2Ws and 36,000 e-3Ws.

Revamp Moto has onboarded Panache Digilife Limited as a contract assembler for their EVs. With this partnership, Revamp will have a facility with a production capacity of 1,50,000 units.
UNDERSTANDING EV CHARGING NETWORK ROAMING AND INTEROPERABILITY

India is currently in the early adoption stage of EVs. CPOs (Charge Point Operators) responsible for building charging infrastructure have their own EV charging Apps to enable users to access their charging stations. In order to access a wide charging network, EV users currently have to install multiple apps by different CPOs.

This is a pain point an eMSP (Electric Mobility Service Provider) can address by aggregating the chargers operated by multiple CPOs on a common platform and allowing the interoperability of chargers among CPOs.

Can you explain how evnnovator is bringing different charging networks together on its platform? How will it benefit the CPOs and the end EV users?

We have built an eMSP platform on the OCPI protocol, which widely covers CSMS (Charging Station Management System) used by different CPOs who wish to participate in roaming and interoperability. The eMSP enables roaming and interoperability that eventually helps the participating CPOs to gain higher utilization, thus, higher revenue potential. Sharing of the charging network among the operators also allows them to offer a wider network to their customers without installing every charger by themselves.

Our solutions built on top of our eMSP platform brings direct benefits to the EV user, such as a single touch point to access a large network, i.e. a unified app that allows locating chargers, charging & payment and a wide number of CPOs.

Which charging protocols are used to support interoperability and roaming?

OCPI and OCPP are two different protocols in the EV charging ecosystem, yet connected to each other.

- **OCPP** - Open Charge Point Protocol, developed and managed by Open Charge Alliance, is an open-source application protocol responsible for communication between the network-enabled Charging Station and its management application or CSMS.

The intent of OCPP is to enable EV chargers manufactured by different manufacturers to work seamlessly with a variety of CSMS (subject to the EV Charger supporting OCPP).

- **OCPI** – Open Charge Point Interface, managed and maintained by EV Roaming Foundation, is the protocol for roaming and interoperability. It helps ensure that EV drivers can charge at any charging station by using a single eMSP (eMobility Service Provider) application, irrespective of charging station being operated by any CPO.
How do you facilitate charging network roaming for the user?

We offer the following solutions to help stakeholders access charging network roaming:

- **FICH App** - A B2C app that offers an end-to-end charging experience to EV users. All the chargers onboarded on the platform from different CPOs are available through this app.

- **FICH for Fleet** - A B2B app for EV Fleet Drivers that enables them to access the charging stations outside their hubs. We work on monthly contracts for payment without the hassle of pay per charge.

- **eMSP API** - A strategic product for the automotive OEMs, EV Charger sharing CPOs, companies building EV Charging apps and other partners who would like to leverage the charging network aggregated by our eMSP platform.

How do you manage the data belonging to different stakeholders?

Our eMSP platform ensures data integrity and manages the data of respective CPO partners separately through our partner management process.

On the customer side, we have signed a contract with an upcoming EV fleet where we will handle the complete Customer and Driver profile data through a separate account management process, including billing, payment and settlement.

What is the current scale of your charger coverage?

We are working aggressively on both the Demand and Supply sides.

- On the supply side, we currently have **100+ DC charging Points** onboarded, which are operated by Charge+Zone. We have signed an MOU with Fortum Charge & Drive to test their **200+ charging points** and work towards roaming services.

- On the demand side, we are working on collaborations with OEMs and fleet operators.

Recommended watch - CEEW video on the need for EV Roaming and Interoperability
**Product Feature**

**CHOGORI FC CONNECTOR PRODUCT SERIES**

The connectors in Chogori’s FC connector product series are used for **Electric 2W and 3W battery swap applications**. The connectors come in 2 socket sizes for different power requirements and allow EV charging and discharging variations based on system design and application requirements.

The power sockets are **Chogori patents** for high current transmission capabilities, and the connectors are a hybrid design that comes with both power and signal.

- **In FC04 Pro**, the power uses 5.7mm sockets for **single-direction insertion** with 10 signal pins.
  - The product is rated for **80V DC**, 100A for power and **5A** for signal.
  - The wire gauge for power can cable up to 25mm².

- **In FC09**, the power is using **3.6mm sockets for bi-direction insertion** with 10 signal pins.
  - The product is rated for **72V DC**, 40A for power and **5A** for signal.
  - The wire gauge for power can cable up to 13mm².

**FC04 PRO Connector for battery swapping applications**

**FC09 Connector for battery swapping applications**

**Enquiries**

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The FC connector product series uses -

- High-strength thermoplastic resin with an operating temperature range of -40°C ~ 105°C
- Conductors are plated in silver or gold
- Battery side connector IP67
- The FC connectors can withstand ≥5,000 mating cycles
- Flammability rating UL94V-0, RoHS and REACH compliant

About Chogori

Founded in 2007, Chogori Technology Co. Ltd. designs and manufactures a wide range of environmentally sealed and rugged connectors for harsh environments and outdoor applications.

The high-technology enterprise integrates design, R&D, manufacturing, sales, and technical services. Chogori has a team of 700 employees and 53,000 square feet of production space in Shenzhen and Dongguan, China. Chogori applies Toyota's Lean management philosophy and has established International Industry Standard Laboratory, where all products are validated according to USCAR2 & 37 specifications and DFMEA validation as per customer requirements.

Enquiries

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- Visit us - http://www.chogori-tech.com/
BYD has launched its sporty electric SUV ATTO 3 in India. Atto 3 SUVs will come to India via the CKD route, and deliveries are expected to start from January 2023. The price is yet to be revealed by the OEM. Salient features:

- 150 kW peak power, 310 Nm peak torque
- 60.48 kWh Blade Battery
- 521 km claimed range
- From 0 to 100 km/h in 7.3 seconds
- DC Charging time (0 to 80%) - 50 min
- AC Charging time using Type 2 (7kW) - 9.5 to 10 hours
- VTOL mobile power station function (to be purchased additionally) allows the vehicle to be transformed into a mobile power bank, which supports power up to 3.3kwh.

Tata Motors Tiago EV received more than 10,000 bookings within the first 24 hours of booking opening on 10 October 2022. The EV, which was launched at an introductory price of INR 8.49 lakhs (ex-showroom) for the first 10,000 customers, was then made available at the same price for the first 20,000 customers.

Tata Motors signed an agreement with ride-hailing platform Evera to deliver 2,000 XPRES T EVs. XPRES brand was launched exclusively for fleet customers in July 2021. Evera is an asset-light EV cab service provider for B2C and B2B segments, plying in Delhi-NCR, The company has raised $5 million pre-Series A funding led by Europe’s EG Investment Banking Group & Devonshire Greens. Prakriti E-Mobility is the parent company of Evera.

Chauffeur-driven cab service provider Carzonrent will transition its entire existing fleet of 5,000 cars to EVs within the next 12 months. The company said that it had completed over 5,000 trips in its pilot phase, testing its EV fleets’ performance. Carzonrent India also launched an EV Mobility as a Service platform called ‘Plug’ that aims to add 20,000 cars to its fleet over 5 years. Plug will service over 600 existing institutional clients through its EV mobility services, a company statement said.

Mumbai-based PMV ELECTRIC will unveil its microcar, The EaS-E, on 16 Nov 2022. Starting price is expected to be between INR 4,00,000 to INR 5,00,000. 2915mmX1157mmX1,600mm, Wheelbase - 2,087 mm, Ground clearance - 170 mm, Kerb weight - 550 kg. 3 variants - claimed range 120 km to 200 km. Can be fully charged in under 4 hours with a 3 kW AC charger.
Tata Motors has won the order for 200 electric buses to be operated in Jammu and Srinagar. 150 units of 9-metre and 50 units of 12-metre Starbus electric buses will be supplied as part of the Government of Jammu & Kashmir’s initiative for environmentally friendly public transportation. As part of the contract, Tata Motors will supply, operate and maintain Tata Starbus electric buses for a period of 12 years.

In August 2022, Switch Mobility partnered with the Bengaluru Metropolitan Transport Corporation to supply, operate, and maintain 300 SWITCH EiV 12 electric buses for the city. The next 100 of these buses were delivered and flagged off at the Yelahanka depot.

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PMI Electro delivered 25 electric buses in Surat as part of a larger order to supply 150 electric buses to the Surat Municipal Corporation. PMI Electro is now present in over 23 cities in India. The company also announced that they have so far delivered 862 e-buses across the country. With their e-Bus network ranging from regions like Rajkot to Ladakh, PMI has clocked more than 1.25 crore green kilometres.

Kalyani Powertrain Limited Pune rolled out the first batch of retrofitted commercial vehicles into the second phase of end application trials. These are old Diesel trucks converted into full electric versions to cater for demands from fleet customers for clean transport solutions. KPTL’s portfolio includes electrification solutions for 7.5 to 14T (GVW) commercial vehicles.

Customer deliveries of the TATA ACE EV started in October 2022. Tata Motors took orders of 39,000 units from aggregators, which include Amazon, BigBasket, City Link, DOT, Flipkart, LetsTransport, MoEVing, and Yelo EV. Ace EV will be launched in nine cities by year-end. Trials finished in Pune and started in Delhi and Gurgaon.

Toshiba India has signed an agreement with EVage Ventures to supply its SCiB™ rechargeable lithium-ion cells to power 10,000 EVage electric commercial vehicles. The agreement guarantees the availability of enough cells in 2023 to meet EVage’s production ramp-up and fulfillment of existing reservations for its delivery vans in India.
The Ministry of Environment, Forest & Climate Change (MOEFCC) introduced the new Battery Waste Management Rules in Aug 2022. These rules and policies are extremely encouraging to the battery recycling industry as the Government of India has taken on initiatives to transition to a ‘circular economy' from a ‘linear economy’.

Venkat Rajaraman (CEO at Cygni Energy) presents an overview of the Battery Waste Management Rules.

**Purpose of Battery Waster Management Rules 2022**

The overuse of fossil fuels and extreme reliance on them has depleted our natural resources, leading to the development of renewable energy alternatives. By focusing on reusing, repairing, refurbishing, and recycling, the circular economy functions as a resilient system that will help us tackle global challenges such as pollution, climate change, waste and biodiversity loss.

In its bid to adopt cleaner mobility alternatives, India is incentivizing the adoption of Electric Vehicles (EVs) through subsidies. However, as the demand for EVs and, thus, lithium-ion batteries (LIBs) grows, steps must be taken to ensure proper battery disposal. This is part of India’s mission for a cleaner tomorrow.

The rules levied aim to resolve the problem of wastage of lithium-ion batteries by focusing on the retention of the batteries. This will promote a circular economy for India through recycling and environmentally friendly care of waste batteries.

**Application of rules**

The rules, as mandated, apply to:

- Producers of batteries
- Dealers of batteries
- Consumers of batteries
- And entities involved in the collection, segregation, transportation, refurbishment and recycling of spent batteries.
The EPR Battery Waste Management Rules 2022 apply to both recyclers and refurbishers of batteries. Refurbishment means repairing, re-conditioning, and re-purposing a used battery for its second life. Application for registration of recycler or refurbisher for grant of one-time registration and quarterly return submissions is also specified as part of this notification.

Types of batteries covered

The rules cover all types of batteries regardless of chemistry, shape, volume, weight, material composition and use. The only exemption from these rules is for the batteries used in essential security equipment, including ammunition, arms, war material and any other material intended specifically for military purposes, and for that equipment that is designed to be sent into space and its exploration.

Extended Producer Responsibility (EPR)

The Rules prohibit landfill disposal and incineration of depleted batteries. Extended Producer Responsibility puts the onus on the producers (including importers) to collect and recycle/refurbish waste batteries and use recovered materials from waste into new materials.

- The Central Pollution Control Board has the authority to grant EPR certificates.
- Those involved in the manufacturing of batteries are obligated to register through a Centralized Online Portal for battery waste management. This portal also allows for an exchange of EPR certificates between producers to fulfil their obligations.
- The Rules have identified clearly-defined recovery targets for each industrial battery.
- The use of certain amounts of recycled materials in the production of new batteries will lessen the burden on new raw materials and thus be more sustainable.
- Lastly, the Rules mandate minimum use of domestically recycled material. This mandate will promote new entrepreneurial ventures and investments, and encourage technological innovation in the recycling/refurbishment of waste batteries.

Other key points

- The consumer is responsible for discarding waste batteries separately from other waste and disposing of it safely by giving it to entities engaged in collection, refurbishment or recycling.
- Public Waste Management Authorities are responsible for collecting waste batteries and handing them over to those engaged in the refurbishing/recycling of batteries.
- Lastly, the Rules ensure that a mechanism will be established for properly auditing and maintaining details with respect to the obligations as per the EPR.
- The Central Government will set up a Committee for Implementation to ensure the effective implementation of the rules established.
Centralised online portal

A centralised Online Portal for the registration and filing of returns by producers, recyclers, and refurbishers of Waste Batteries is envisioned. The system shall ensure a mechanism wherein the material balance of Waste Batteries as per Extended Producer Responsibility obligations of Producers is reflected. It shall also reflect the details regarding the audit of the producers and entities involved in refurbishing and recycling.

The State Pollution Control Board shall also use the web portal of the Central Pollution Control Board used for registration of Producers for registering entities involved in refurbishing and recycling waste batteries. The web portal would act as the single-point data repository with respect to orders and implementation guidelines.

India opportunity

India is lagging in the Lithium-ion battery (LIB) recycling race so far.

For 10 GWh of battery packs in the next five years, India needs an excess of 60,000 tonnes of battery recycling capacity.

Companies like Attero, Recykal, Lohum, LICO, Li-Cycle and Karo Sambhav are focusing on eWaste and LIB recycling, but then India needs a far greater recycling capacity if we aim to be a leader in Urban Mining.

Pitfalls to watch out for

We need to come up with a robust implementation plan for such policies so that it doesn't suffer the fate of lead-acid battery recycling.

Lead-Acid batteries are mostly recycled by the informal sector, despite having a clear policy. Improper and environmentally unfriendly recycling by the informal sector has been a major concern for policymakers. The presence of an informal sector and lack of monitoring have resulted in an ineffective system of recycling mainly driven by the interests of the informal sector. We hope that the execution of Battery Waster Management rules 2022 will be planned in a more effective manner.

Summary

India is at an inflection point regarding Recycling. Only time will tell if Lithium Recycling is Achille’s heel or a Golden Opportunity. This is truly a BHAG (Big Hairy Audacious Goal) that India needs to achieve. Time for India to prove that if there is a Goliath in front of you, that means there’s a David inside of you!

- Laminations for all rotating e-mobility applications
- Self-bonded, Welded, Riveted and Cleated Stators
- Self-bonded, Riveted and Die Cast Rotors
- Laser Cutting with Stacking for Prototypes
- Development of Punching Tools
- Machining of Stators and Rotors
- Stator Winding with Rotor Shaft Insertion
- Copper Coils
- End laminations

Focused on processing superior grades in thickness 0.20 / 0.25 / 0.30 / 0.35 / 0.50 mm
Prime Electrical steel is sourced directly from reputed Steel Mills

Modern testing and inspection facilities incorporates epstein test frame, franklin tester, rotor analyzer, stator core tester, optical cmm and more.

Capacity to punch 2000 mt/month of finished laminations.

Not Just Laminations - Total Solutions

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+91 9925100520, +91 79 6163908
info@poggenamp.com
www.poggenamp.com
Ahmedabad-based **Naxatra Labs** announced the launch of its **axial flux powertrain for EVs**. The motors are designed for e-2Ws as mid-drive motors. **Currently undergoing testing along with Joy E-bikes (Wardwizard Innovations & Mobility)**, the start-up claims its motors provide up to a 10% increment in average efficiencies compared to existing radial flux motors in the same segment.

**Saietta VNA**, the JV between Saietta Group and Padmini VNA, will begin electric drive production in India in **2023 from its new facility in Delhi**. The electric motor (RFT85-65) is based on **radial flux technology** and has been developed for 2W and 3W applications for the Indian market. This air-cooled unit produces 4 kW of continuous power at 48V and can be integrated with Saietta's power electronics and transmission.

The RFT85-65 is anticipated to be produced in India **alongside Saietta's AFT140, an axial flux technology motor** for premium motorbikes and lightweight 3W and 4W applications.

As per a report by tempo.co, **Transport Ministry of Indonesia is offering free Type Test Registration Certificates for OEMs to accelerate the approval and registration of electric 2Ws**. Currently, there are 35 electric 2W companies in Indonesia and 28,000 vehicle test certificates have been issued so far. The government targets having two million e-motorcycles by 2025.

**The Asian Development Bank mobilized a $135 million climate financing package for VINFAST for manufacturing Vietnam's first fully-electric public transport bus fleet and first national EV charging network**.

Established in 2017, VinFast is a subsidiary of Vingroup Joint Stock Company, Vietnam's largest private enterprise.

**Sony Honda Mobility Inc (SHM)**, a 50:50 JV between Sony Group and Honda Motors, was established in Sep 2022 with a capital of 10 billion yen. The companies have agreed to joint development and sales of high-value-added EVs and create a business to provide mobility services. SHM plans to manufacture its first product at **Honda’s North America factory**, with sales to commence in 2025.

**Saudi Arabia’s** Public Investment Fund and Hon Hai Precision Industry Co. (Foxconn) have launched the first **Saudi EV brand ‘Ceer’**. Ceer vehicles are scheduled to be available in 2025. Each vehicle will be designed and manufactured in Saudi Arabia. **The company will license component technology from BMW**. Foxconn will develop the electrical architecture.
Additional testing parameters to enhance EV safety released on Nov 2, 2022
- The Ministry of Heavy Industries has issued a notification to make certain tests mandatory from Apr 1, 2023, for claiming incentives under the PLI Schemes for Automobile and Auto Components, Advanced Chemistry Cell Manufacturing and FAME 2. These additional tests are to be performed at the cell level (as per international standard UL 1642), battery pack level and BMS level.

Uttar Pradesh Electric Vehicle Manufacturing and Mobility Policy 2022 was approved by the state cabinet. With the notification of this policy, the UP Electric Vehicle Manufacturing and Mobility Policy 2019 shall lapse. The state government has outlined a budget of INR 500 crores for purchase incentives across vehicle categories. Registration charges are exempted for the first 3 years; and also for years 4 and 5 for vehicles manufactured in the state.

Tirex Chargers bagged the contract to supply EV chargers at Hindustan Petroleum Corporation Limited’s 60 retail outlets in Gujarat and Rajasthan. It will supply two types of DC fast chargers - one rated between 25 to 30 kW with a single connector option of CCS2 and the other rated between 50 to 60 kW, with combinations of connectors as per requirement. This adds 3MW to Tirex’s existing supply of more than 20MW worth of chargers PAN India.

Servotech Power Systems has been awarded a project by Bharat Petroleum Corporation (BPCL) to supply and install 800 units of DC fast EV Chargers. The project is worth INR 46.2 crores and is expected to be completed by 31st March 2023. The project will span across the country, equipping petrol pumps in major Indian cities with EV Charging capabilities.

Mahindra & Mahindra entered into collaboration with multiple EV charging network companies, including Statiq, CHARGE+ZONE and Jio-BP, to provide charging solutions ahead of its electric SUV launches. By the end of this fiscal, Mahindra’s EV users will have access to the Charge+Zone’s network of 2500+ charging points across 25 cities and 10,000 km of highways. Starting with 16 cities, Jio-bp will install DC fast chargers at the M&M dealership network and workshops across India.

Quench EV Chargers (part of Ador Group) has launched its range of 180kW and 240KW EV chargers - The Tallboy.

The charger is designed for the global market and will be deployed in parts of the EU, USA, South East Asia, and the Middle East in addition to India. The charger is suited for premium electric cars like the Mercedes EQS, EQC, Jaguar I-pace, Audi Etron, Kia EV6 etc. - charging from 0 to 80% in nearly 20 mins. The charger is also suitable for electric buses which follow the CCS2 standard.

Electric two-wheeler mobility platform eBikeGo is going international through its fully owned subsidiary in Europe (eBikeGo EU) with the appointment of the Spanish director Ivan Contreras as the CEO to lead the international expansion. This company would be engaged in international sales of its EVs Muvi & Velocipeido.
COMPONENTS OF A LITHIUM-ION CELL - PART 4 | SEPARATOR

A Lithium-ion cell is built of various components and sub-components. This article discusses the functionality and importance of selecting the right type of (sub) components.

A Lithium-ion cell has four major components:

1. Cathode - Positive electrode
2. Anode - Negative electrode
3. Electrolyte - Medium for the movement of lithium ions
4. Separator - Prevents contact between cathode and anode

The earlier parts in this series talked about the Cathode, Anode and Electrolyte. In this article (part 4), author Rahul Bollini discusses the Separator.

Out of the four major components of a Lithium-ion cell, the separator is likely the least discussed. Thought of as a plastic material, the separator seems very simple from the outside.

However, when studied in depth, the separator is a fascinating component with multiple parameters. Choosing from the various parameters makes the number of possible combinations of separator specifications very high. No single type of separator can cater for all kinds of Lithium-ion cells.

What is a separator?

As the name suggests, a separator is used to separate the positive and negative electrodes. The separator is a plastic material placed between the electrodes. The separator ensures that the electrodes do not touch each other and prevents short-circuiting within the cell. It is supposed to allow the smooth flow of lithium ions from the cathode to the anode during charging and from the anode to the cathode during discharge.

What are the types of separators?

There are three major types of separators, Dry, Coated and Wet, as described below:

- **Dry separator**: It is manufactured by melting the polymer and then stretching it in a single direction. It is the *oldest, simplest and cheapest technology* of separators for Lithium-ion cells, and it is still popular today. A dry separator tends to be thicker and can have multiple layers.

*One of the popular models is a tri-layer PP/PE/PP separator, which is 25μm (micrometer) thick. The thickness of dry separators popularly ranges from 12μm to 25μm.*
**Coated separator**: In a coated separator, the base film (dry separator) has an external coating of ceramic (alumina or boehmite), PVDF-HFP (Polyvinylidene Fluoride-Hexafluoropropylene) and nanofiber (aramid). The coated separator has a higher temperature meltdown (>200°C). Listing the commercially available combinations of coating on separators:

a. Ceramic coating on one side of the base film but no coating on other side of base film.
b. Ceramic coating on both sides of the base film.
c. Ceramic + PVDF coating on both sides of the base film.
d. Base film has ceramic coating above it on one side and PVDF coating above the ceramic coating. There is no coating on the side of the base film.
e. Ceramic coating on one side of base film, PVDF coating on the other side of base film.
f. Base film has ceramic coating above it on one side and PVDF coating above the ceramic coating. It is the same arrangement on another side as well.
g. Nanofiber coating on both sides of the base film.
h. The base film has a nanofiber coating above it on one side and a PVDF coating above the ceramic coating. It has the same arrangement on the other side as well.

**Wet separator**: It is manufactured by mixing the polymer resins with paraffin oil and other additives, heating the mixture, making it into a thin sheet-like film, removing the additives to create micropores and then stretching the film.

The wet separator has a very tensile strength in TD (transverse direction) or CD (cross-machine direction) when compared to the dry separator, which can be as high as 3200Kg/cm^2 in wet separator as compared to around 200Kg/cm^2 in the dry separator. Wet separators are very popular in low thickness, and their thickness starts from 4μm. High-energy density cells use low-thickness separators to improve the volumetric energy density.

*The manufacturing setup of wet separators is very expensive, and the process of manufacturing wet separators is expensive and complicated. Hence, wet separators can cost 3x to 5x the cost of dry separators.*

**Important parameters of separators**

- Material of the separator - can be PP (polypropylene) or a mix of PP and PE (polyethylene).
- No. of layers - can go up to 3 layers. For example, PP/PE/PP tri-layer separator.
- Overall thickness of the separator - can vary from 4μm to 40μm.
- Porosity - can vary from 30% to 60%. Porosity is in the nm scale, and the pores close when the cell experiences high temperature. Generally, it is close to 40%.
- Gurley value – is the time required for a specific amount of air to pass through a specific area at a specific pressure, expressed in seconds. Its value ranges from 120 to 350 seconds/100ml in dry separators, and from 90 to 180 seconds/100ml in wet separators
- Electrolyte wettablility – a critical characteristic of the separator because the absorption of the electrolyte is important for the transportation of lithium ions. The wettablility process undergoes as soon as the electrolyte filling is done in the cell.
- Ionic conductivity – measured in Milli-Siemens per centimetre.
• TD or CD shrinkage at various temperatures after one hour, e.g. at 90°C, the shrinkage should be less than 1% after one hour.
• MD (machine direction) shrinkage at various temperatures after one hour. e.g. at 90°C, the shrinkage should be less than 5% after one hour.
• Tensile strength in MD, e.g. is about 2000 Kg/cm^2.
• Tensile strength in TD or CD e.g. can be up to 200 Kg/cm^2 in the dry separator.
• Puncture strength - is measured in grams. Its value ranges from 280 to 550 grams in dry separators, and from 280 to 780 grams in wet separators.

Facts about lithium-ion cell separators

• Widest of all the three materials, winded (cylindrical and prismatic cells) or stacked (pouch cell) inside a Lithium-ion cell, meaning its width is more than the width of the cathode and the anode of the cell.
• Separators are made up of polyolefin material, which is either polypropylene or polyethylene or both combined. These materials have very good chemical and mechanical stability and are cost-effective.
• LFP chemistry cells, most of the time, use a single-layer PP dry separator. It is the cheapest type of separator out there.
• NMC and NCA chemistry cells tend to use different types of separators in the range of coated separators and wet separators.
• Tri-layer separator made up of PP/PE/PP is very popular because, in case of high temperatures being reached inside the cell, the middle layer of PE melts and shuts down the cell operation without losing mechanical integrity. It is possible because the melting point of PE (around 130°C) is lesser than PP (around 160°C).
• In a solid-state battery, the solid electrolyte placed between the electrodes eliminates the use of a separator.

Separators are a customized product, and a cell manufacturer generally shares their requirement with a separator manufacturer. Selection of the separator for the Lithium-ion cell is an art because there are no fixed definitions. Also, there can be more than one type of separator that can work well with a type of Lithium-ion cell.

About the author

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