

Contents

Electric motor developments	Page 1
EV market developments	Page 3
Technology spotlight	Page 4
Technology market share	Page 5
Assessment methodology and glossary	Page 5

For subscription or editorial enquiries please contact:

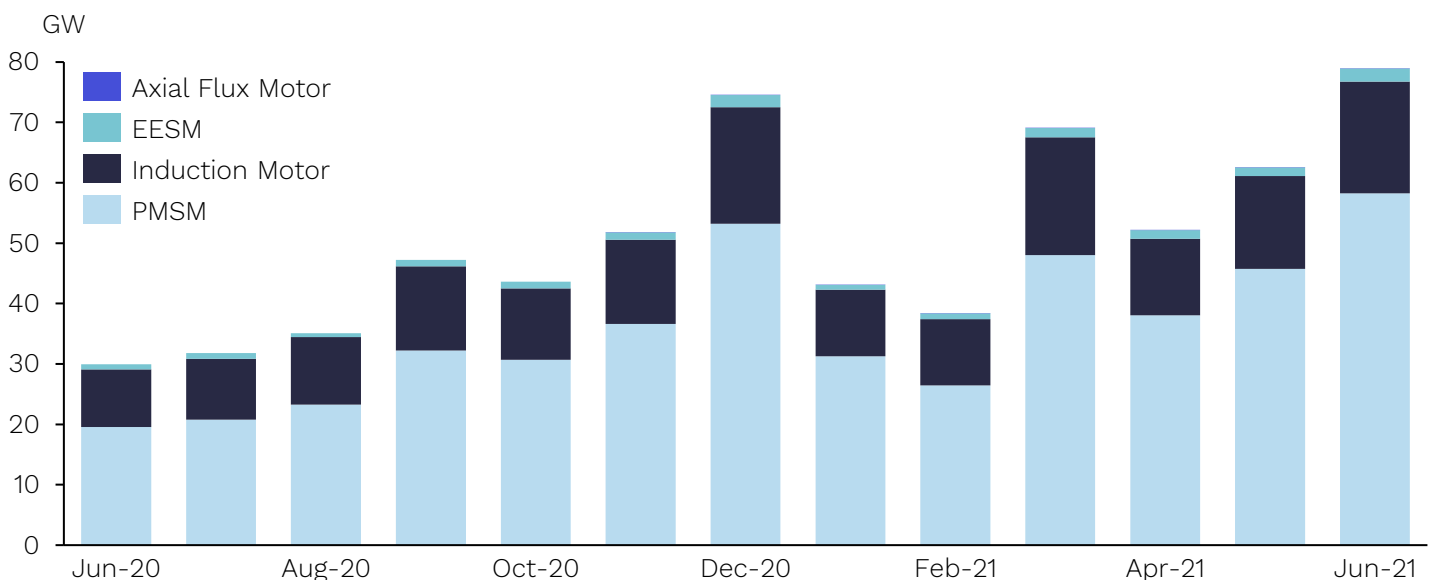
Email: Info@rhomotion.com
Tel: +44 (0) 203 286 8936

Report methodology and glossary can be found on the final page

EV motor developments this month

- At its 2021 strategy update: ‘Electric Drive’, Mercedes-Benz discussed plans to reorganise its powertrain activities. It announced the acquisition of UK-based electric motor company YASA. The Oxfordshire based manufacture specialises in axial-flux technology, a type of PMSM with very high power density. Mercedes-Benz stated it plans for the axial flux technology to play a key role in the electrification of the AMG brand due to its high performance characteristics. YASA will now also help Mercedes-Benz to bring powertrain and specifically motor development in-house. YASA will continue to operate independently as a subsidiary and supply its current customers from its existing facilities. You can learn more about the axial flux technology in this month’s ***technology spotlight***.
- LG Electronics and Magna have completed the agreement to begin operations in a new joint venture preliminarily called LG Magna e-powertrain. The JV will manufacture electric motors, inverters, onboard chargers and complete electric drive systems. Magna has experience with electrified powertrains and LG Electronics with the electrical components used in motors and inverters. The new JV deepens LG’s stake in the electric vehicle space.
- GKN Automotive, a prominent supplier of electric motor technology to the passenger car and motorsport sectors, announced the acceleration of its 800 volt technology development. GKN stated it is now working with leading automotive manufacturers to make these systems a production reality. GKN’s partnership with Jaguar Racing (Formula-E) has helped progress this development as the demand for 800 volt systems ramps up quickly for the next generation of EVs.

Global Monthly PC & LDV EV motor demand by technology type



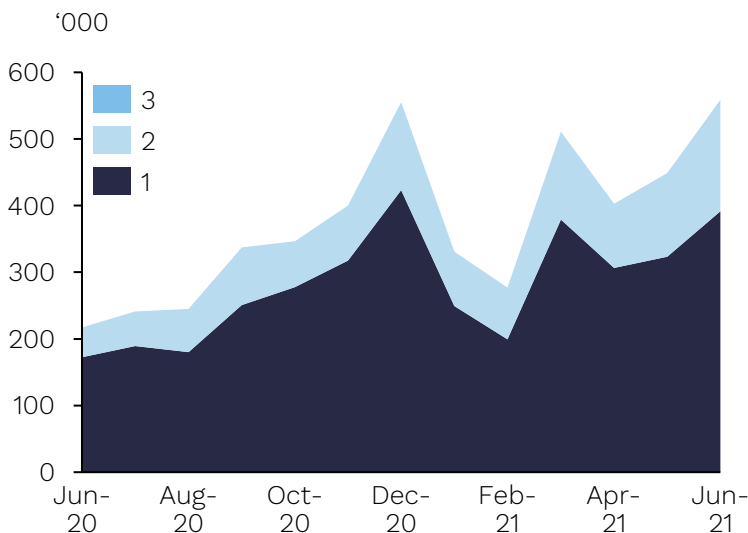


Monthly EV Motor Assessment July 2021

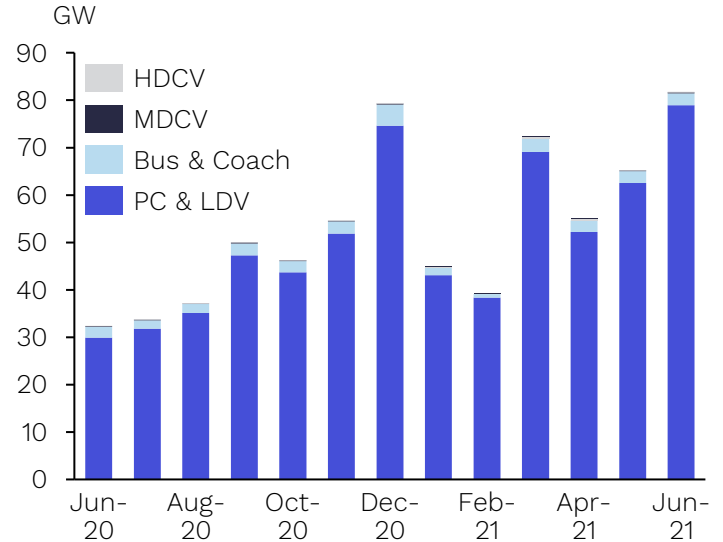
www.rhomotion.com

- Nidec is in talks to set up a joint venture with Taiwanese manufacturing giant Foxconn. The joint venture aims to boost the volume of Nidec's e-axle and electric traction motor products, with sales targets of 2.8 million units in 2025 and 10 million units in 2030.
- Sietta Group announced it is listing on the London Stock Exchange's AIM market with the goal of raising £37.5 million in capital. The step aims to support the progression to the mass production of Sietta's axial flux electric motor.
- Sona Comstar from India and IRP Nexus Group from Israel are working together to jointly develop a new powertrain which does not use rare earth elements in its design. Mass production is expected to begin in 2023 in India. The initial design is aimed at the large Indian electric two and three wheeler market.
- Rohm has formed a strategic partnership with Geely for the development of advanced automotive technologies. The first output of this partnership is the use of Rohm's Silicon Carbide traction inverter to be used in an electric vehicle platform currently under development by Geely.
- STMicroelectronics announced a breakthrough by manufacturing its first 200mm Silicon Carbide wafers, enabling a marked increase in capacity.
- BYD announced the first vehicle on it's 800 volt e-platform 3.0 will be the BYD Dolphin.

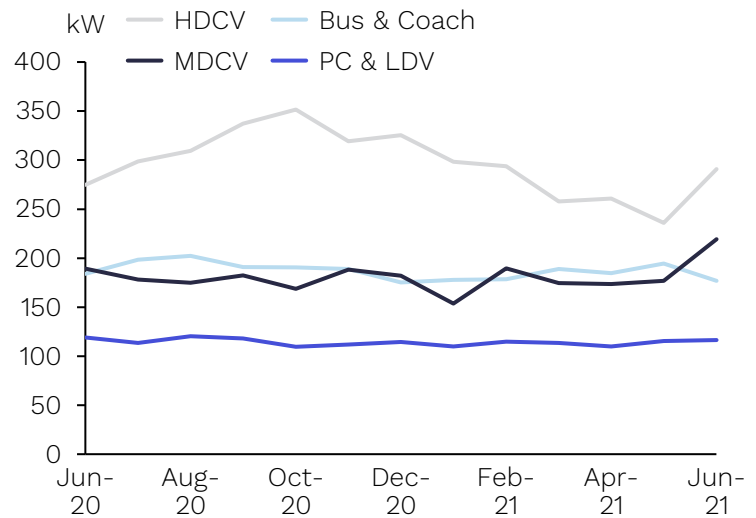
BEV & PHEV sold by number of motors



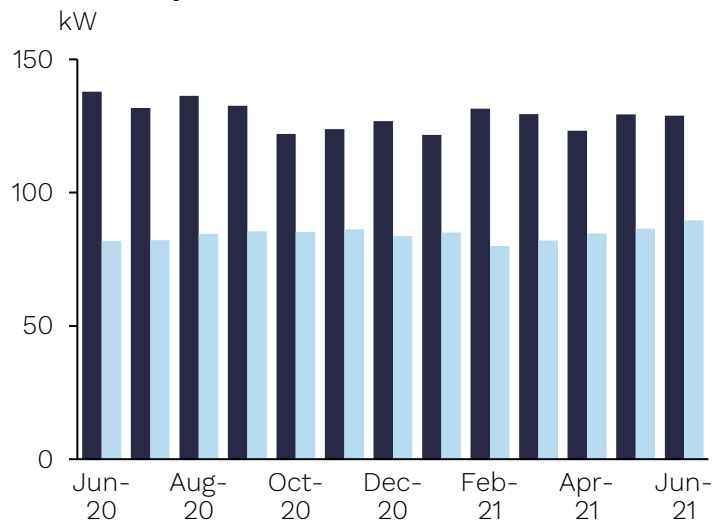
Global monthly EV motor demand by vehicle type



Average vehicle electric power



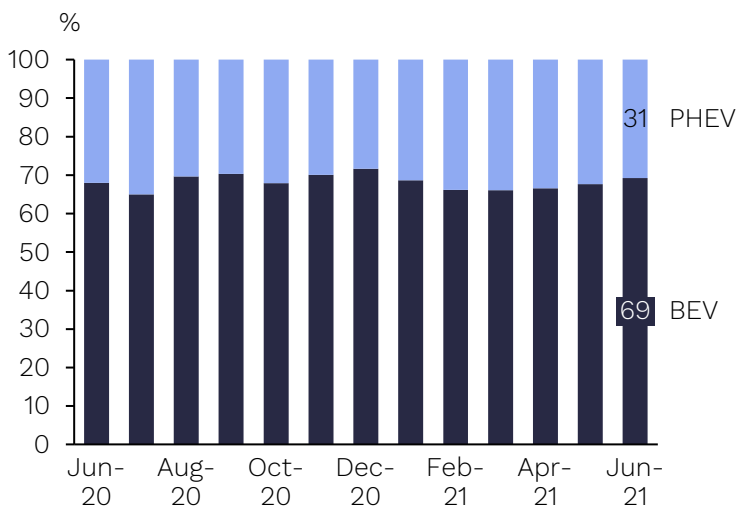
Monthly sales weighted average EV motor power BEV & PHEV



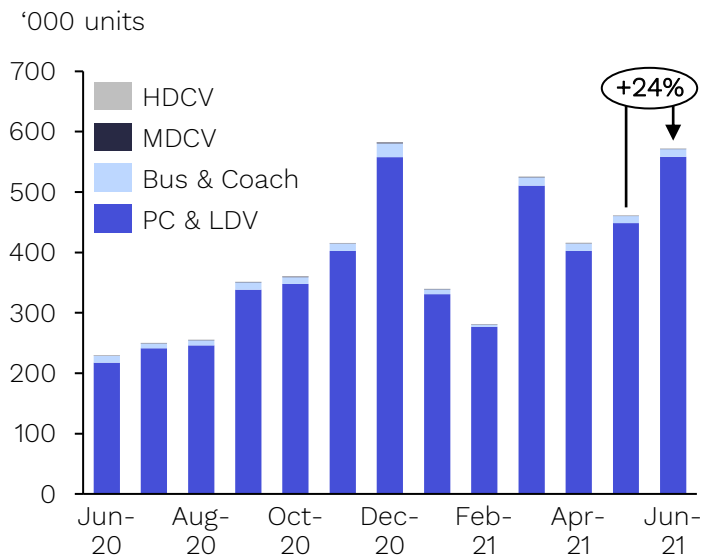
Electric vehicle market developments

- Overall BEV & PHEV sales increased by 24% m-o-m in June 2021, with over 570,000 units sold. A new record was set for global monthly EV PC & LDV sales of 558,000 units. In the first half of 2021, global EV sales exceeded 2.5 million, a significant increase on 2020 that saw total year sales of 3.2 million. June was a strong month for China, setting a new record, with 234,000 PC & LDV sold.
- New models released in China included two version of the VW ID.6. The FAW-VW ID.6 X sold over 1,000 units, and the SAIC-VW ID.6 CROZZ over 500 units. The two version are essentially the same vehicle on VW's MEB platform, but produced through two different partners. The ID.6 offers single motor options of either a 132kW or 150kW PMSM. A dual motor option adds an 80kW induction motor at the front.
- Also released in China was the Letin Mengo, a small 4-seater with a 130km NEDC range and the option of a 25kW or 35kW PMSM. The low cost vehicle, with a starting price of 29,800 yuan (€3,815), will be targeting the same market as the best selling SAIC-GM-Wuling Mini, and achieved close to 1,000 sales in its first month.
- Audi expanded its offering of the Q4 e-tron to the wider European market, with close to 2,000 units sold this month. Two new variants also now on sale see a smaller AWD option added with 195kW system output.

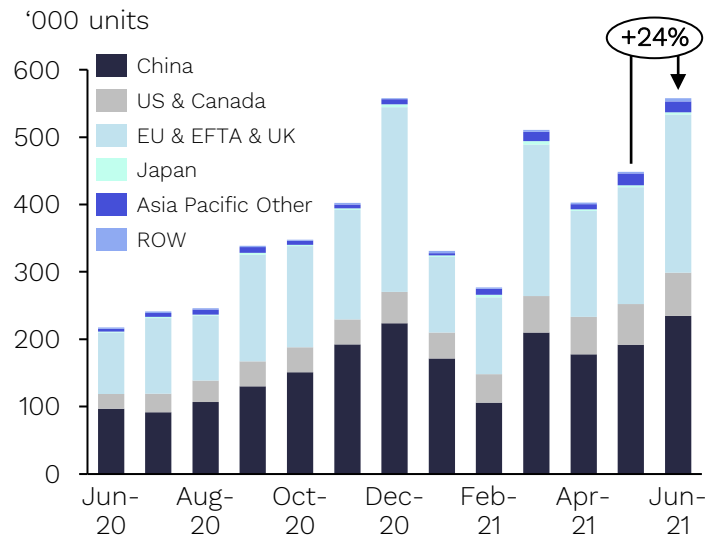
Global PC & LDV BEV/PHEV market share



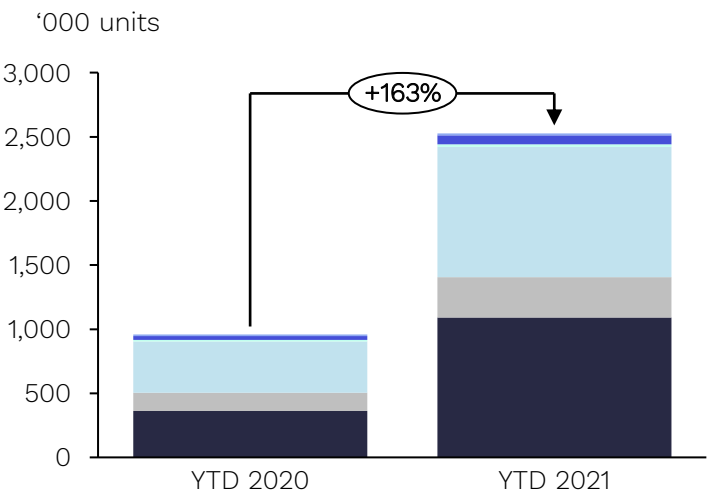
Global Monthly EV sales by vehicle class



Regional Monthly PC & LDV EV sales



Regional Year-to-date PC & LDV EV sales

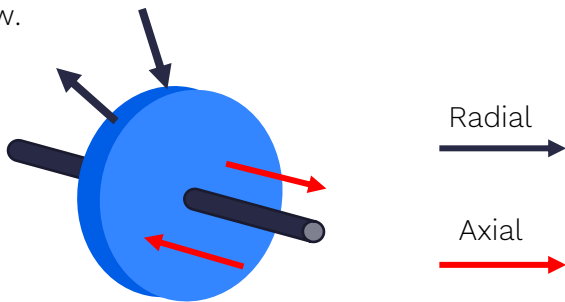


Technology Spotlight: Axial Flux Motors

Axial Flux motors have come to the spotlight this month due to the acquisition of YASA motors by Mercedes-Benz, who plan to utilise the technology in the forthcoming AMG.EA platform. Axial flux motors make the perfect candidate for a high performance electric vehicle drive due to the very high power to weight ratio achieved.

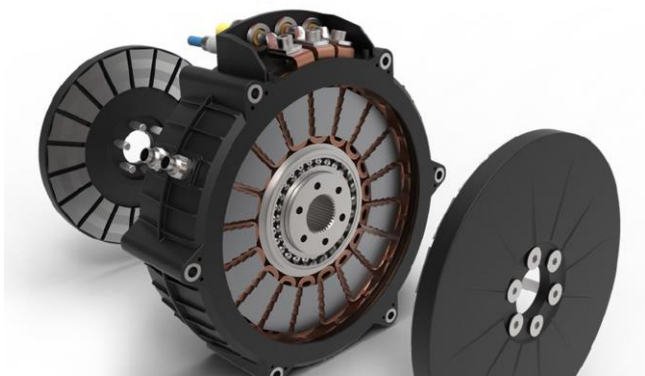
What does axial flux mean?

In this report, PMSM refers to the radial flux design, this means the direction of magnetic flux in the motor is radial, perpendicular to the rotation axis, as indicated by the black arrows in the diagram below.



Axial flux refers to the direction parallel to the rotation axis, in this diagram represented by the red arrows. The flux direction is dependent on the orientation of the permanent magnets to the stator.

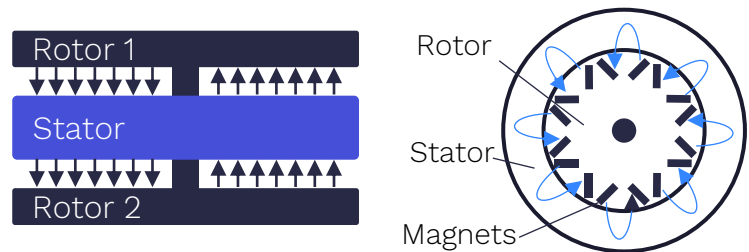
There are a number of key benefits this axial flux design can help achieve. The image below shows a schematic of how one axial flux motor is constructed – this motor design is from Dutch start-up Magnax. The central section is the stator with copper windings around steel, the outer sections are rotors with permanent magnets.



Source: Magnax

The first benefit of this design is it allows the minimum distance between the stator windings and the magnets on the rotor. Reducing the distance flux has to travel, increasing how effective it is.

Secondly the path of the magnetic flux is more simple in an axial design, the path is a straight line from rotor to stator as shown below. In a radial design the flux leaves the rotor and turns 180° to return to the rotor – a far less efficient path.



Left: Straight line flux linkage between rotor and stator in the axial design is the most efficient path. Right: 'out and back' flux path in radial design is less effective.

As the lines of flux only travel in one direction, grain-oriented steel can be used in the stator, allowing for iron losses to be reduced in a way that is not possible in radial flux designs.

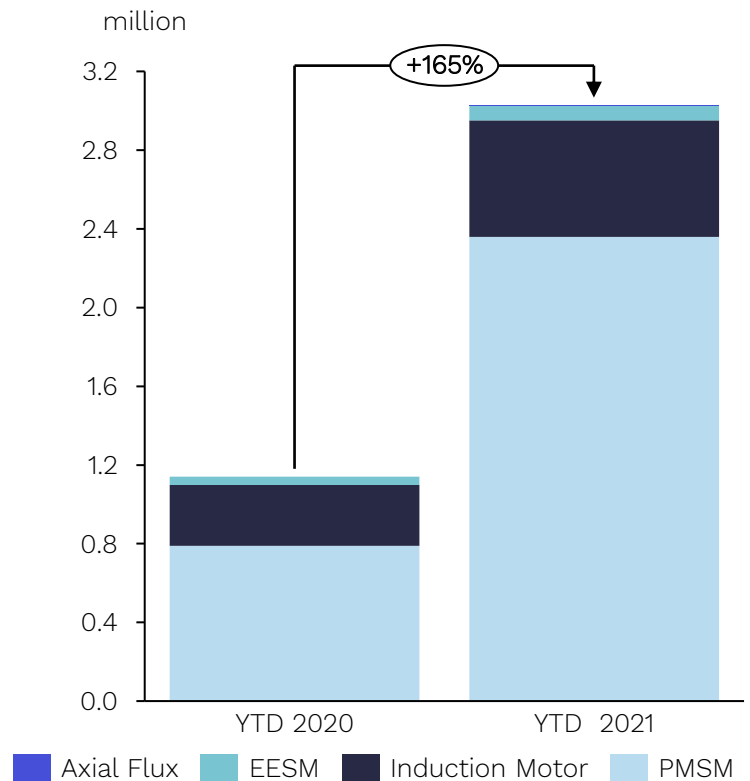
The design of these motors comes with some challenges, they can be difficult to manufacture, needing costly non-magnetised composite materials like carbon fibre. Furthermore, thermal management can prove to be difficult and the exact methods of cooling are usually guarded by the manufacturers.

Real world tests have shown a power density of 2-3x higher than the best performing radial flux designs. So far the technology has had limited use in the market, first appearing in production with the Ferrari SF90 Stradale in 2020 as one of three electric motors. Other limited run supercars have also used the technology. With Mercedes-Benz's acquisition of YASA motors as well as a number of other firms looking to enter the market - such as Saitta and Magnax - it may not be long before axial flux motors make up a more significant portion of the market.

Monthly market share by technology

Motor Type	GW EV motor demand	Motor type market share
Induction Motor	18.50	23.4%
PMSM	58.23	73.8%
Electrically Excited Synchronous Motor	2.19	2.8%
Axial Flux Motor	0.01	<0.1%
Total	78.93	

EV motor deployment PC & LDV by type, Units



Assessment Methodology

- This assessment provides a weighted average of EV motor technology by technology type across passenger car and light duty vehicle, bus and coach, and medium and heavy-duty vehicle sectors. EV sales data is collected on a model-by-model basis from automotive associations, OEMs and data providers at country level for both BEV and PHEV vehicles for major markets.
- This analysis covers a minimum of 95% of total global market sales and provides a balanced representation of markets with different vehicle characteristics, suppliers and seasonality. Where EV specific model data is not explicitly stated estimates are used based on industry and company reports and primary research. These are then corroborated or adjusted when official data becomes available.
- Where vehicles offer more than one specification either in number of motors or motor power a calculation is made based on available data detailing the split of sales between each model spec.

Assessment Glossary

Vehicle: EV – Electric Vehicle, BEV – Battery Electric Vehicle, PHEV – Plug-in Hybrid Electric Vehicle, PC – passenger car, LDV – Light Duty Vehicle, MD – Medium Duty, HD – Heavy Duty, CV – Commercial Vehicle.

Motor and Power Technology: PMSM – Permanent Magnet Synchronous Motor, EESM – Electrically Excited Synchronous Motor, AC – Alternating Current, Si – Silicon, SiC – Silicon Carbide, IGBT – Insulated Gate Bipolar Transistor, MOSFET – Metal-oxide-semiconductor field-effect-transistor, eV – electron Volt

Battery: LTO – Lithium-titanate, LFP – Lithium iron phosphate, LMNO – Lithium Manganese Nickel Oxide, LMO – Lithium Manganese Oxide, NMC – Lithium Nickel Manganese Cobalt Oxide, NCA – Lithium Nickel Cobalt Aluminium Oxide, LCO – Lithium Cobalt Oxide, NCMA – Nickel Cobalt Manganese Alumina