



The smart battery innovation

A pioneering innovative technology for a more sustainable and efficient EV battery production

*“Sustainable
Li-ion
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Ralf Hock
IP PowerSystems GmbH

E-mobility is one of the most prominent issues of our time as it can solve many of the occurring world problems like environment pollution and climate change. Still, electric vehicles remain a niche market. The main obstacles to boost an e-mobility revolution lie in the high costs and the environmental impact, i.e. the sustainability of the Li-ion battery cells. So, innovative materials and processes receive continuously increasing attention to lower production costs and to enable a “greener” battery production.

A major ecological and economic problem is the energy consumption to create a moisture-free atmosphere necessary for cell production for the protection of the moisture-sensitive electrolyte and electrode materials. Large dry rooms consuming high operating costs are hardly to avoid.

After extensive research one company has developed a new and efficient solution to overcome this unfavourable issue.

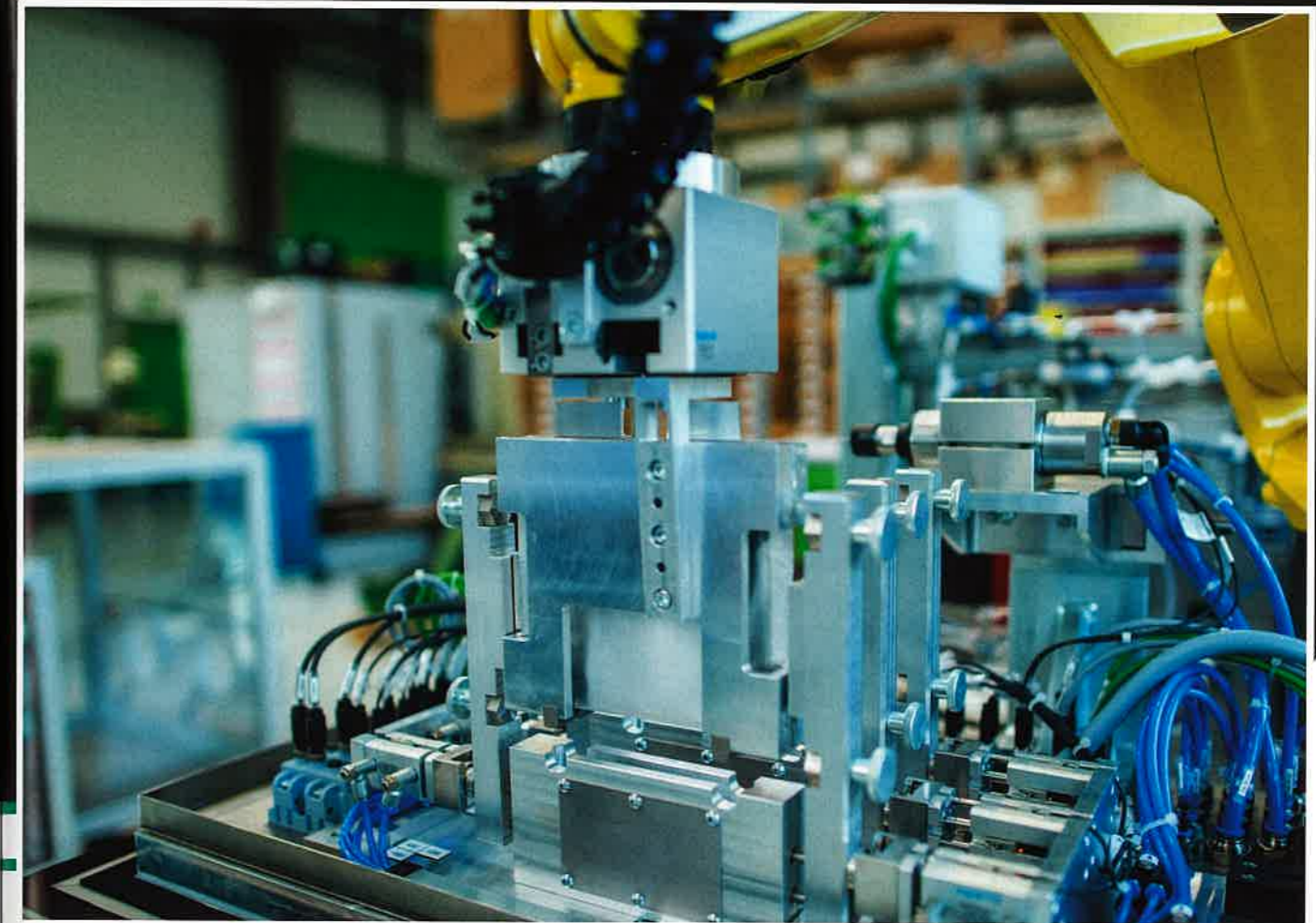
In the town of Coswig, northwest of Dresden Germany, IP PowerSystems GmbH develops processes and designs machines which offer efficient and ecologically advantageous solutions for the automated and sustainable

production of lithium-ion battery cells. Here, Ralf Hock, managing director of IP PowerSystems GmbH, explains a pioneering technology that he is convinced will lower costs and the carbon footprint for EV battery production.

As a result of the company's extensive R&D efforts, an innovative technology arose with the aim of finding an effective and environment-friendly alternative to the conventional production of Li-ion battery cells.

The result of which enables electrolyte filling at ambient atmosphere without a dry room, a process which has not been possible until now. This novel “Method for producing electrolyte pouch cells for electric battery arrangements, corresponding device and electrolyte pouch cells”, is patented with international application number WO 2016/198145 A1. It includes a new production process starting with the cell assembly and final sealing before the filling step.

The assembly of the cell components – i.e. the electrode-separator-stack with welded-on tabs and the pouch foil – is completed similar to conventional production. Additionally, closed filling plugs – so called ports – are integrated



within the seam of the pouch cell for the sealing process, which can be performed in a dry microenvironment. The sealing machine executes the complete and hermetical sealing of the cell. Due to this pioneering technology no special dry/clean atmosphere is needed for the next steps in process. Subsequently, the hermetically sealed, dry pouch cell is transported to the filling without the need for a dry room. The number and position of ports are adapted to the required cell size and electrolyte quantity. Access into the cell is realised by penetration of one or multiple ports by dosing needles. The needles are specially designed to enable vacuuming and filling of the cell with the same needle. Both process steps can be realised by one or multiple needles. Due to the flexibility in filling, the wetting of the electrode surface with electrolyte can be improved.

The wetting of the electrode surface, especially wetting of the large pore surface of the electrochemically active electrode material, is one of the crucial bottleneck steps and can take up to 48hs. Due to the novel technology of IP PowerSystems GmbH, this process can be accelerated by fast spreading of the electrolyte within the cell and by adjustment of temperature as well as pressure.

In the conventional production process the filling is typically done in a vacuum chamber. Such is not required in the filling machine of IP PowerSystems GmbH. Here, the filling under standard pressure facilitates a pressure difference between inside (vacuum) and outside (standard pressure) of the cell leading to faster wetting. The technology also provides the opportunity to reduce process time and hence production costs.



Directly after filling, the ports are sealed off by sealing clamp jaws. Thus, the cell is hermetically closed at any time. In addition, the contaminated sealing seam is minimised resulting in reduced negative effects on the battery's lifetime.

The formation gas, which is generated during the activation/formation process, can be extracted by the degassing machine utilising port and dosing needle. The degassing can be accomplished in one step after the formation or continuously during the formation. The latter is another novel, patent-pending technology by IP PowerSystems GmbH. This eliminates the need for conventionally used gas bags for the collection of formation gas. These gas bags are typically contaminated with electrolyte resulting in high disposing costs and efforts as hazardous waste.

The process flexibility is granted for all required process conditions. The requirements and conditions were determined in collaboration with OEMs, manufacturers for niche products and research institutes. This also includes the format flexibility. All existing pouch cell formats can be produced on the machines based on this innovative technology. The company provides equipment for cell production

from sample quantity up to mass production covering niche applications as well as mass applications. IP PowerSystems GmbH not only has different technologies for electrolyte filling of pouch cells but also has further significant developments for the sustainable and automated production of cylindrical and prismatic cells.

Automation of cell manufacturing can make a substantial contribution to a lower overall energy consumption of the Li-ion battery cell production.

A flexible and module-based automation system to efficiently optimise the complete cell production is Robo Automation Kit, which has been developed by the company. The Robo Automation Kit is a flexible, universally applicable automation kit in which various modules can be combined and existing machines and production lines can be easily integrated. If required, the modules can be re-combined to form a new solution allowing a flexible process adaption of production lines for pouch, prismatic and cylindrical cells.

The modules of Robo Automation Kit consist of the same Basic Unit with integrated switch and control cabinet. Due to its very small size, it fits in any



Pilot Filling Machine



Robo Automation Kit

place of an existing production. With the camera image recognition system and the menu-supported sequence control, no robot programming knowledge is required.

Existing machines of a cell manufacture can be easily automated by Robo Operator® for a production line. Robo Operator® is a self-working, mobile and flexible automation solution for operating and handling different kind of production machines. Neither mechanical connection to the production machine nor data exchange interface is required. An employee without special robot setup knowledge can commission Robo Operator® on the intended machine within a very short time, so that Robo Operator® can work completely on its own without intervention or supervision. Eventually, the vision of flexible production becomes reality.

In collaboration with research institutes, it is planned to equip Robo Automation Kit and Robo Operator® with AI and machine learning in order to be able to react flexibly to new circumstances or disruptions in the process chain. The method of machine learning has numerous advantageous aspects in predictive maintenance and predictive process control to reduce ramp-up time.

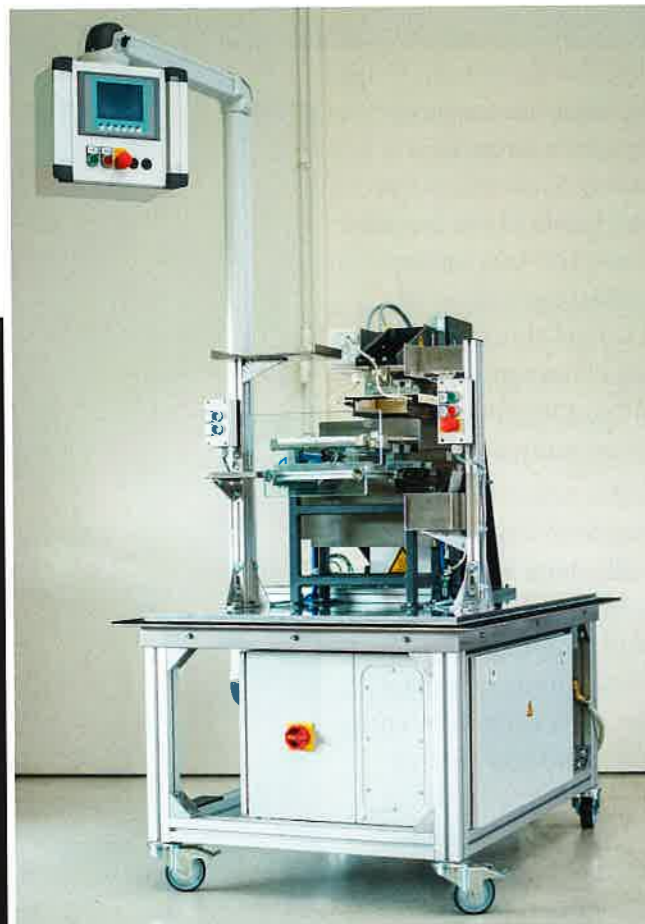
In summary, a "greener" and more efficient Li-ion cell production can be reached by the innovative technologies and developments of IP PowerSystems.

Sustainable Li-ion battery cell production with less overall energy consumption bears various advantages, especially for mass production.

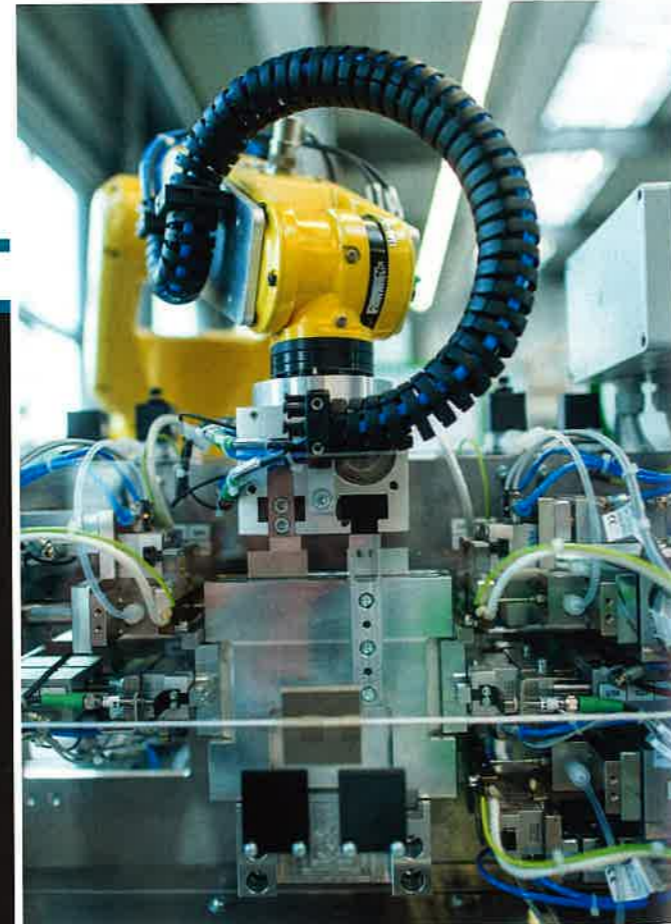
The filling without dry room results in considerably reduced expenses, energy consumption and carbon footprint. Due to the elimination of the gas bag, no excessive amount of pouch foil is required and costs as well as effort for the disposal are reduced contributing to a sustainable cell production. Accessibility of different filling strategies allows for the acceleration of the wetting procedure, one of the crucial bottleneck steps.

Lower overall energy consumption and thus, further enhancement in production efficiency can further be accomplished by automation of the cell manufacturing, e.g. with the help of Robo Automation Kit and Robo Operator®. The modules of this flexible construction kit can be easily combined and recombined to achieve flexible production lines for pouch, prismatic and cylindrical cells.

"Thanks to the company's new developments and its special expertise we are able to play a big part in our customers' success. We are convinced, the use of our pioneering technologies will pave the way towards the e-mobility revolution." Ralf Hock concluded.



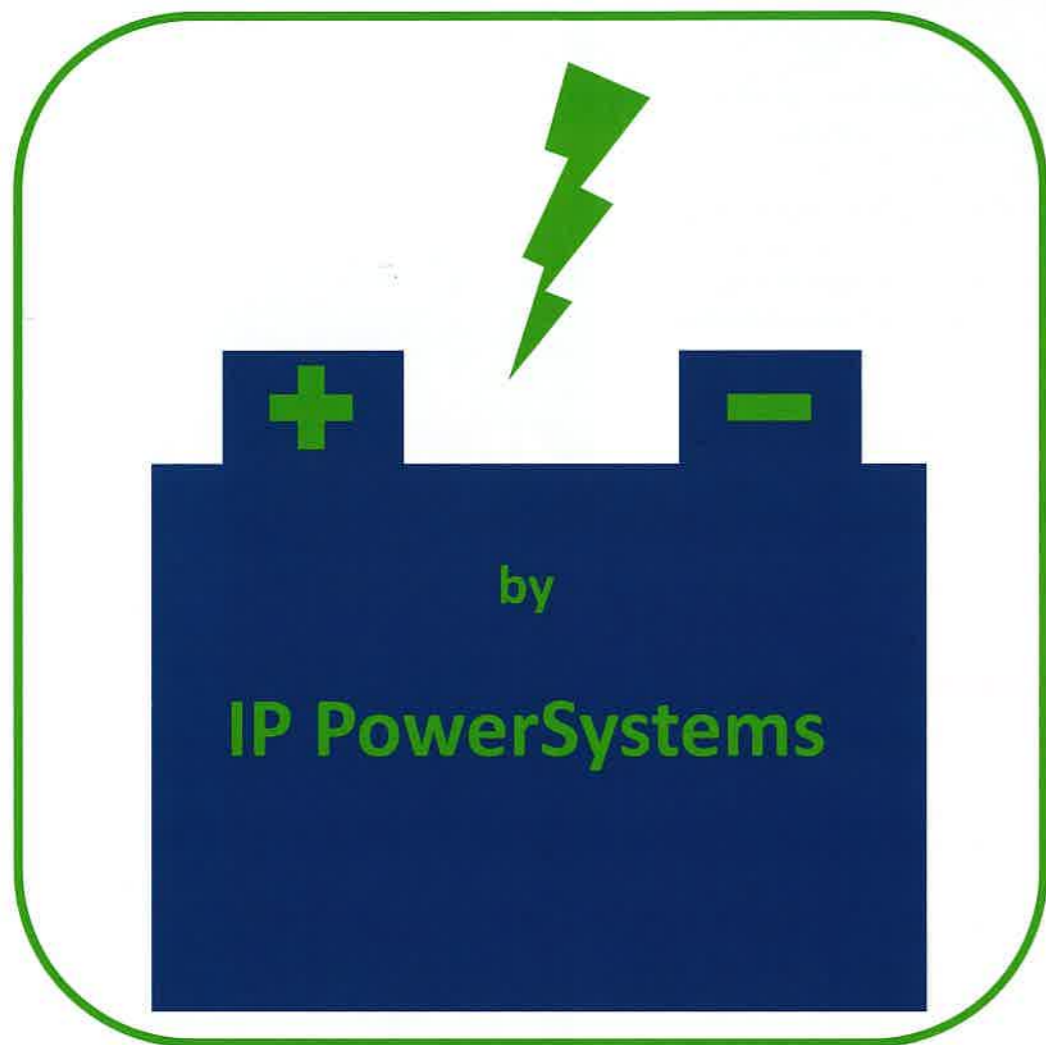
Pilot Sealing Machine



Pilot Filling Machine

The Smart Battery Innovation

The novel technology for sustainable and automated Li-ion cell production



The innovative technology of IP PowerSystems with enormous advantages:

- No dry room needed for cell assembly, electrolyte filling and degassing
- Huge reduction of costs and carbon footprint
- Strongly accelerated, homogeneous wetting after electrolyte filling
- Reduction of disposal effort and costs

Check details at:
www.ip-powersystems.com



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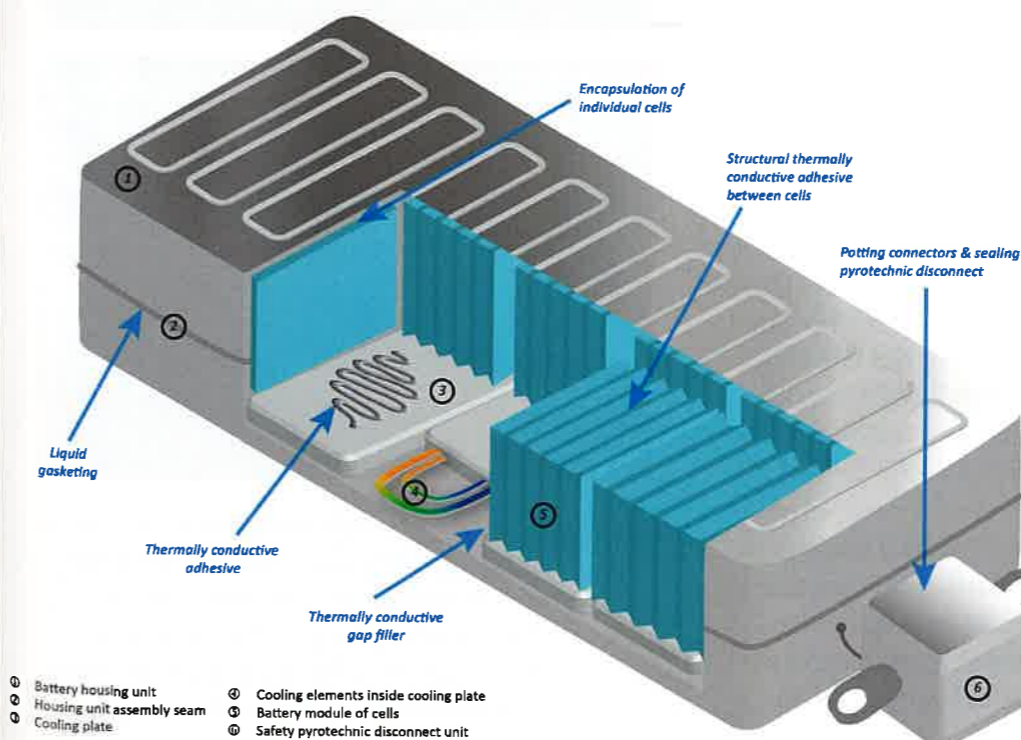
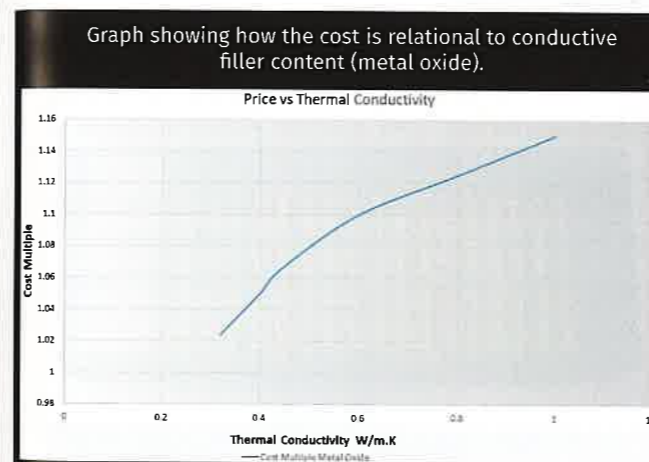


Industrie-Partner
IP PowerSystems GmbH
An der Walze 11
01640 Coswig
Tel.: 03523-8 31-0
info@ip-coswig.de

Cost.

Capital expenditure costs of implementing adhesive on a production line vary depending on the level of automation required and sophistication of the equipment. It is possible to use adhesives for minimum outlay. Handheld dispensing guns. Overheads will vary according to the amount of space required and cost of running and maintaining equipment. Adhesive products themselves, considering the amount of adhesive used per battery, will come under ongoing cost scrutiny. It is interesting to note, the level of thermally conductive filler and the nature of the filler is the main cost driver for thermally conductive adhesives.

Higher levels of thermal conductivity can be achieved with different, more expensive fillers, but dielectric strength can be affected, with materials becoming electrically conductive – for some applications, this is great, but in the case of high voltage batteries for



electric vehicles, probably not so desirable!

Where are adhesives and sealants used?

- Encapsulation or potting of battery cells
- Bonding cells into modules
- Bonding modules to cooling plate / heat sink
- Gasketing and sealing the battery pack
- Encapsulation and potting of other sensitive electronic components
- Potting of connectors and sealing pyrotechnic disconnect units

As well as battery bonding, high performance adhesives are also used for electric motor bonding – bonding magnets to rotors, magnets to stators, and sealing motor housing. Motors are often requiring adhesives to withstand 180-220°C as well as rigorous impact and thermal shock testing. In the event of an accident, a pyrotechnic disconnect unit detonates to release the battery system to help prevent fire and electrocution, adhesives are used to secure and pot connectors as well as seal and protect units. Friable adhesives can be used to secure the explosive charge, similar to those found in airbag detonation devices.

“ Here at Permabond we have a portfolio of special developments combining high thermal conductivity, fire retardancy, toughening, and also adhesives with high-temperature resistance. We have a long and impressive history of supplying adhesives to the automotive industry worldwide, with many products specified by leading automotive manufacturers and Tier 1 automotive suppliers, who insist on high quality cutting-edge products. Bespoke formulations can be developed to meet our customers exact requirements, helping them to achieve production savings and performance benefits. ”