Fraunhofer FEP

PRESS RELEASE

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New production process for metal-on-polymer current collectors

Fraunhofer FEP has developed a new roll-to-roll production process for manufacturing metal-on-polymer current collectors. This technology enables the precise application of copper and aluminum layers onto polymer films to produce current collectors with electrical conductivity and thickness comparable to conventional metal foil-based current collectors. These results provide industry with a valuable basis for optimizing lithium-ion batteries.

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It is hard to imagine our modern world without lithium-ion batteries. They enable us to use mobile devices such as smartphones, tablets, robot vacuum cleaners, and electric vehicles. However, the many advantages, such as high energy density, compact design, and long service life, are offset by one major disadvantage: due to the properties of lithium (highly flammable and highly reactive), there is always a certain risk of fire. Overcharging, damage, or overheating can lead to an uncontrolled release of the stored energy. This is called "thermal runaway".

The process developed makes it possible to replace conventional current collectors, usually metal foils, with metal-on-polymer current collectors. These consist of polymer foils coated on both sides with a thin layer of aluminum or copper. These current collectors offer several advantages: They reduce the weight of the collector, which leads to a higher energy density of the cell. Even more important, however, is the safety aspect: if a short circuit occurs in the battery cell, the polymer substrate melts and interrupts the current path. This prevents heat from continuing to build up and causing thermal runaway.

As part of the PolySafe project funded by the German Federal Ministry of Education and Research (BMBF), Fraunhofer FEP developed a new process for depositing metal coatings using a roll-to-roll process. The metal layers are applied to the polymer films by electron beam evaporation. Claus Luber, technical project manager, explains: "The challenge was to design the polymer films and the coating process in such a way that the thickness of the current collector could be comparable to that of current metal films and the metal layer could have optimum electrical conductivity." It was necessary to gain a comprehensive understanding of the influence of parameters such as web speed, substrate pretreatment, and metal evaporation, and to develop optimal process settings to meet the technological and economic requirements. Another challenge was to minimize heat load during the deposition process, which was achieved by using a

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special cooling method, a gas cooling drum from VON ARDENNE GmbH. This solution ensures high film quality and high productivity.

Process development results

The research team successfully demonstrated the deposition of thick copper and aluminum layers on 12 µm thick PET films. Deposition was carried out in a roll-to-roll process on a roll width of up to 60 cm. The results include:

Copper:
Double-sided coating using a two-step process with copper layers up to 1 µm thick per side; the copper layer was compact, and the film remained free of significant wrinkling – ideal for further processing in battery production.

Aluminum:
Double-sided coating using a two-stage process with aluminum layers up to 1 µm thick per side. Here, too, the film was free of wrinkles, confirming its suitability for further processing into electrode coatings.

Successful production of pouch cells

The metal-on-polymer current collectors manufactured using the new technology were successfully integrated into pouch cells by the project partner TU Braunschweig. These cells were tested for their electrochemical properties and compared with conventional reference cells. In these tests, the cells with metal-on-polymer current collectors performed similarly to the reference cells in terms of performance and cycle stability at different charging and discharging rates.

Conclusion and outlook

With the new roll-to-roll process, metal-on-polymer collectors can be successfully manufactured using semi-industrial processes. The research results prove that these processes are suitable for manufacturing current collectors that have the potential to increase the energy density of battery cells while minimizing safety risks. The new production process provides the industry with a basis for the further development of lithium-ion batteries with improved properties.

About the PolySafe project

Research project to increase the safety of lithium-ion batteries using metal-on-polymer composite current collectors

Funding body: German Federal Ministry of Education and Research (BMBF)
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Project partners:
- VON ARDENNE GmbH
- Brückner Maschinenbau GmbH & Co. KG
- Fraunhofer Institute for Electron Beam and Plasma Technology FEP
- Fraunhofer Institute for Surface Engineering and Thin Films IST
- Battery LabFactory Braunschweig (BLB) of the TU Braunschweig
- VARTA Microbattery GmbH

Electron beam evaporated copper-coated polymer film for use as a metal-polymer current collector (composite current collector) for battery cells
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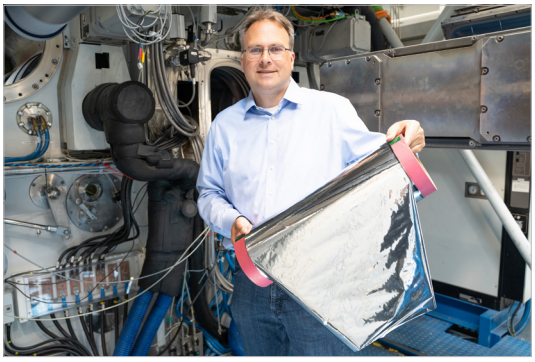
Picture in printable resolution: www.fep.fraunhofer.de/press



Project manager Claus Luber shows a sample of polymer film coated with aluminum using electron beam evaporation
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