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SYSTEMS TECHNOLOGY FOR COST-EFFECTIVE AUTOMATED CELL PRODUCTION

THE TASK

As before in battery research, technical solutions are being researched in order to reduce the production costs of lithium-based batteries and thus, to force a more intensive market penetration of this storage technology. Within the scope of the Federal Ministry of Education and Research (BMBF)-supported research project DryLIZ (KIT 02PJ2302), IWS together with project partners has set itself the task of shortening the process time of electrode assembly and optimizing the transport of the electrodes toward the stacking stage. Electrode cutting and storage should be performed in a minimized dry air volume in order to keep process costs low.

Another research focus is the development of innovative electrode concepts that go beyond familiar electrode production routes. In addition to developing wet coated electrode materials based on water instead of organic solvents, dry processed electrodes with new electrode designs are being developed. Their performance compared to standard electrode systems is investigated (see pp. 70-71).

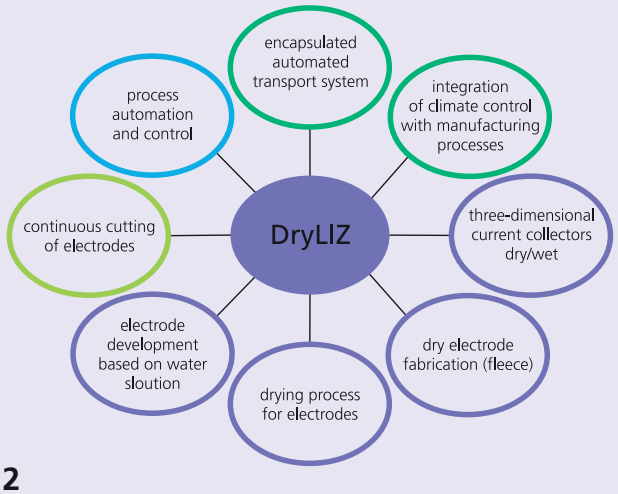
OUR SOLUTION

A fast, interruption-free assembly and packaging of the electrodes increases the throughput of cell production. Continuous electrode cutting processes were evaluated with respect to processing speed, quality of the cutouts, process stability, and tooling costs. Roll stamping technologies with continuous feed of different electrode materials were compared to laser cutting with scanner technology.

The target of fabricating one cutout per second and transferring it both quickly and damage-free posed a big challenge. For the nearly contactless electrode transport, an ultrasound-based transport system was installed, by which the electrodes float on an air cushion.

The handling of dry processed or wet coated and subsequently dried electrodes required defined environmental conditions in order to avoid an irreversible loss of usable electrode capacity. Through the dry air technology developed in the project and the process-customized housing, the applied dry air with a dew point of -40 °C prevents rewetting the electrodes.

Development foci within the DryLIZ project



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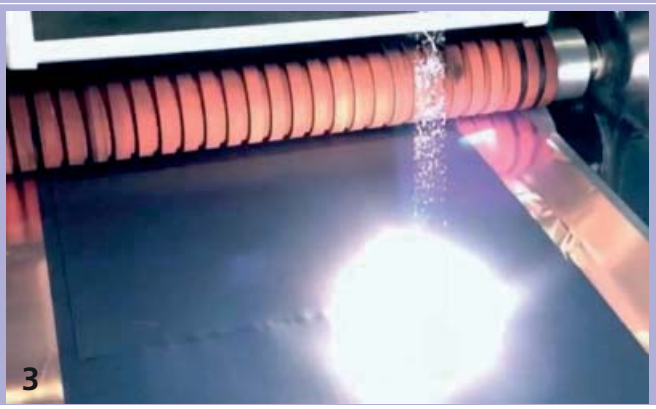

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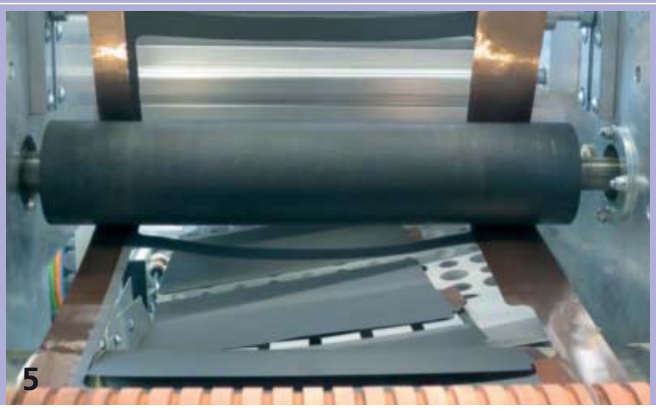

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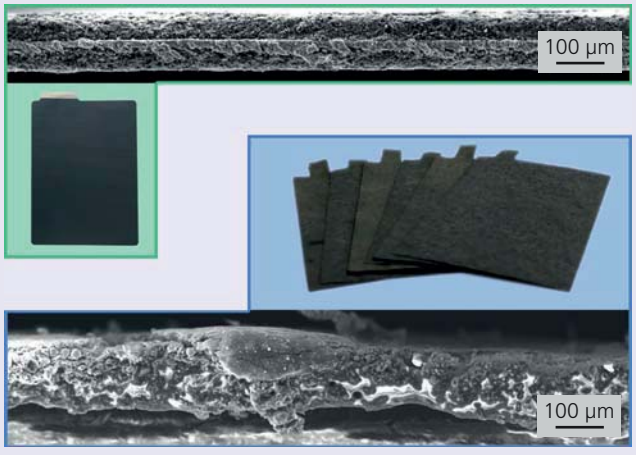
RESULTS

It was impossible to realize reproducible continuous electrode cutting based on roll stamping processes. The laser remote-cutting process on the other hand worked very well with an inexpensive cw single mode laser. This technology achieved good cutting results and high processing speeds. At a transport speed for the electrode material of 200 mm s^{-1} the A5 format cutouts were generated with a cycle time of under a second.

The dry-processed electrodes originating from the project's material development could likewise be cut with the laser. With these electrodes, a conductive 200 µm thick fleece serves as carrier and current collector for the pressed active material. At this point of the development, the new design still cannot be processed by continuous laser cutting "on the fly". However, the smaller format sheets of this material were statically cut by laser and provided evidence of the basic functionality of this new electrode system.

Laser cutouts and SEM images of laser cut edges of the electrode materials (green: water-based coated electrode material, laser cut "on the fly"; blue: dry processed fleece cathode, cut statically)



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The successful transport of the electrodes was demonstrated. The individual cutouts were picked up by an ultrasound conveyor system without demonstrable damage or contamination. They were transported either freely hanging or floating to another transport element and transferred into magazines.

Within the scope of the DryLIZ project the entire packaging and transport process was demonstrated in a dry air volume that was minimized for the respective processes. Compared to large dry air rooms, the costs of air treatment were reduced significantly. With regard to the laboratory operations of Fraunhofer IWS, the reduction is about 90 percent, only 10 percent of the entire room volume was air-conditioned. The plant operators work in natural room air.

The entire demonstrator for electrode and cell manufacturing is available for further research with partners from science and industry after the successful completion of the project.

1 System overview of cutting and transporting in dry air
3 Laser cutting of fleece cathodes
5 Transportation of cutouts

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