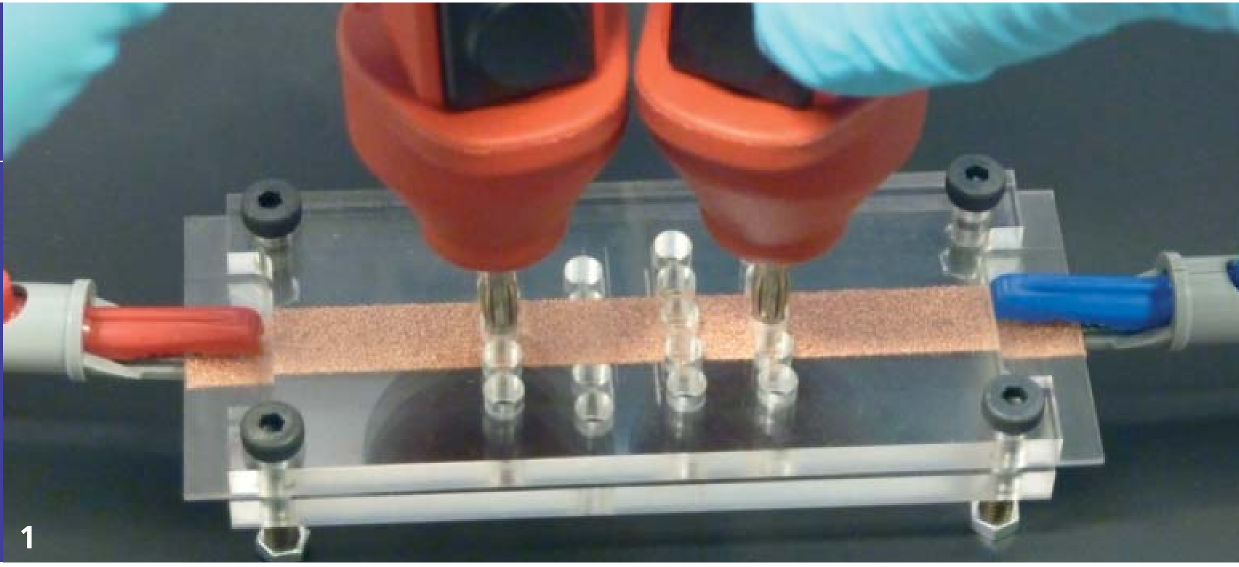
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ADHESIVE BONDING OF METAL CONDUCTORS TO TRANSFER ELECTRIC ENERGY

THE TASK

The development and integration of efficient, safe and low-cost electrochemical energy storage devices is a key technology for applications in electro mobility and the use of alternative energy sources. To guarantee reliable power delivery, such devices storage energy to balance strongly fluctuating electricity loads.

Typical energy storage devices consist of several cells, which are connected with each other. The contact resistance of these connectors should remain very low over the lifetime of the device to maintain device performance, safe and reliable operation.

The cells are connected in parallel. During the assembling process the anode and cathode tabs are mostly ultrasonically welded. The ultrasonic welding process introduces mechanical vibrations, which can cause “soft-shorts” between the electrodes, when parts of the active material peel off.

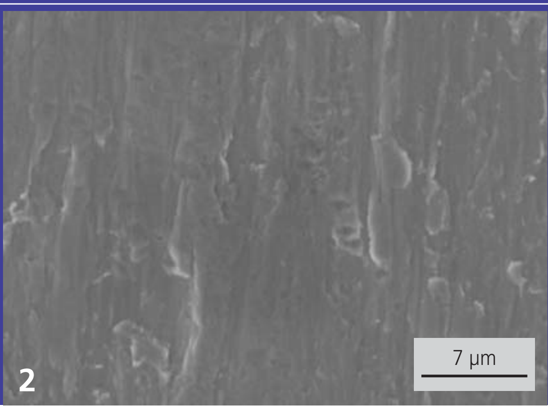
All known processes to fabricate and join such cell stacks require complex fixtures and positioning of the current collector plates and tabs. Solutions are sought to simplify this process and to make it more reliable for use on an industrial scale.

OUR SOLUTION

Fraunhofer IWS offers alternative solutions to achieve low contact resistances for applications where other joining methods are only of limited use due to technological or economic reasons.

The IWS process combines a custom-tailored surface treatment of the joining parts with the application of a special adhesive that is adapted to the particular application. After depositing the adhesive, pressure is applied to plastically deform the micro contacts until the adhesive is cured. The electrically conductive surface between the contacts is several times smaller than the apparent contact area. The remaining surface that did not form micro contacts is then available for adhesive bonding.

One application is the connection and fixuring of current collector foils and the tabs during the stacking process of lithium ion cells. The adhesive was selected so that it is chemically resistant to the electrolyte. The adhesive itself is electrically insulating (conductivity of $5 \cdot 10^{-12}$ S/m) and cures within seconds. The adhesive was purposely not modified by adding electrically conductive additives to avoid particle migration during charging and discharging cycles of the cells.



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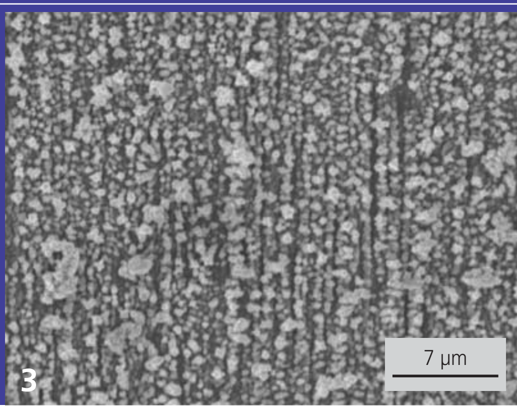

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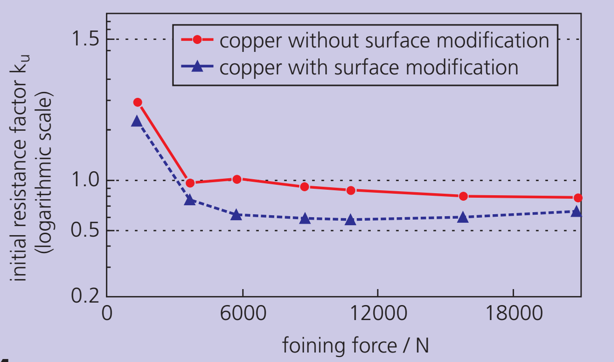
RESULTS

Adhesives are conventionally used for low current and low power contacts. The here presented method is capable to produce adhesive bonded current-carrying contacts, which meet the much higher requirements of energy power supply technologies. The total connection resistance of such adhesive bonds is a few µΩ and the joining process is very fast.

In addition, the method can easily join different conductor materials and geometries over a wide temperature range (e.g. from liquid nitrogen at -196 °C to 100 °C and higher). The method also protects the contact surfaces from a variety of media influences.

Decisive factors to achieve low connection resistance are the selection of a suitable adhesive, the surface preparation of the contacts and the applied joining pressure. Fig. 4 shows the influence of these factors for copper anode foils, which were bonded with and without surface modification.

Dependence of performance factor from joining force and surface structure



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The quality of a connection is evaluated by the performance factor k_u, which allows a comparable representation of different materials and contact cross sections. This factor is the ratio of the resistance of the connection R_V measured over a length l_V to the resistance R_L of the homogenous conductor material with the same geometry and length l_L. If $k_u = 1$ then the power loss and heating over the connector is equal to the power loss over the regular metal conductor.

The results show that it is possible to achieve electrically conductive adhesive joints with a performance factor $k_u \leq 1$ when the joining force exceeds a specific threshold. When using surface-modified anode foils, the results improve further and the process window can be shifted to lower joining pressures.

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1 Setup for the determination of connection resistances

2/3 SEM images of the surface structure of a virgin (left) and a modified (right) copper foil

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