

# Printed Batteries

## Battery manufacturing using printing processes

Printing process / Printed anode

Using screen printing, Fraunhofer IFAM offers alternatives for battery production. New manufacturing concepts allow higher active material loads and greater freedom in electrode design. Completely printed batteries help to break free from the limitations of current manufacturing technologies and to reduce the use of solvents and subsequent drying processes. Fraunhofer IFAM combines battery expertise with profound know-how in additive manufacturing.

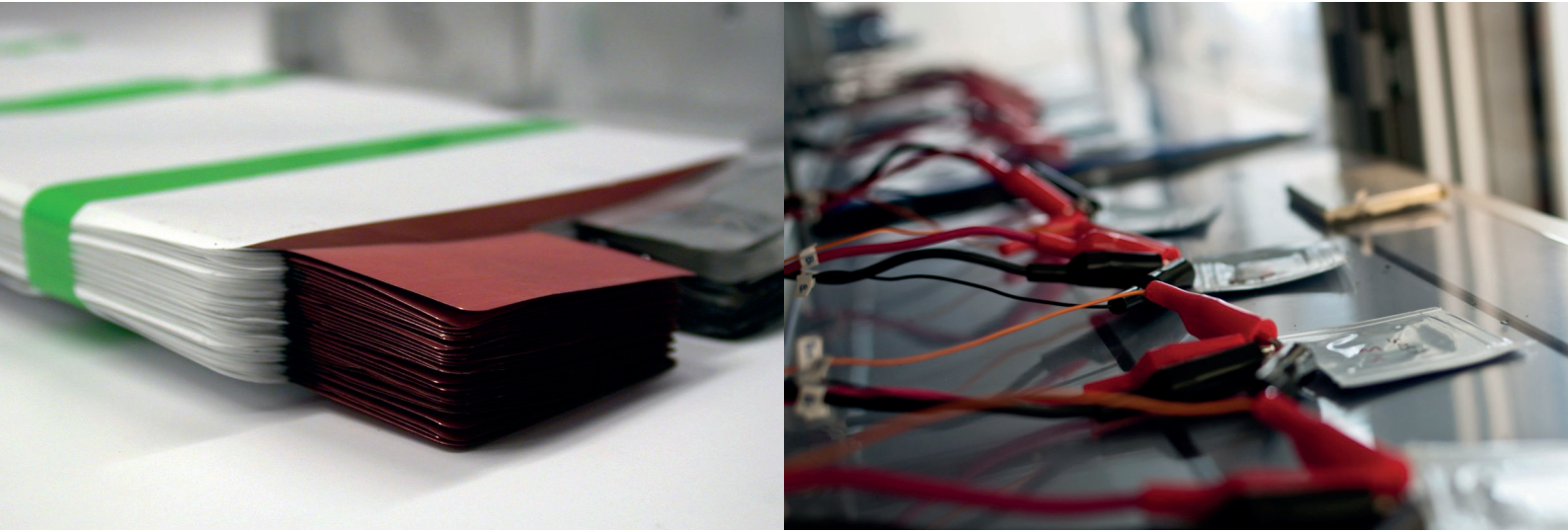
### Green battery of the future

The topic of energy storage is currently more present than ever before. The greatest challenges include increasing the specific energy density and improving environmental friendliness through the use of alternative materials and recycling. To meet these challenges, Fraunhofer IFAM is researching and developing environmentally friendly energy storage technologies and processes, as well as solid-state batteries, which are produced using alternative manufacturing techniques such as screen printing. Prototypes of additively manufactured anodes, cathodes, cells and batteries have already been developed.

### Advantages at a glance

Our approach of printing batteries has several advantages, e.g.:

- Higher energy densities
- New electrode designs through “near-net-shape” printing
- Higher active material loading using reduced amounts of solvent
- Battery production on demand
- Development of new printing pastes
  - Ni-/Co-free materials
  - Water-based formulations
  - Pastes for sodium-ion-batteries



Left: Multilayer electrode stack  
Right: Battery and aging tests under defined conditions

### Additive manufacturing processes

Our experts have extensive know-how in paste production for printed electrodes.

This includes:

- selection of suitable materials (active materials, conductive additives, binders, rheology additives, solvents)
- formulation of the paste according to the individual, specific requirements of the application of the battery cells to be produced
- homogenization of the pastes by means of suitable dispersion processes (e.g. Dispermat, three-roll mill or extruder).

The screen printing process represents one possibility for the production of printed electrode layers. Depending on the application of the battery, the design is adjusted to provide e.g. high power or high energy. Based on this, printing parameters are optimized at Fraunhofer IFAM especially with regard to mass production. Additionally, Fraunhofer IFAM provides simulation tools for the design of battery cell stacks.

### Our offer

Fraunhofer IFAM offers you the following R&D services in this field:

- Printed batteries consulting service
- Feasibility studies for printed batteries including:
  - Selection and evaluation of active materials
  - Development and evaluation of printing pastes
  - Matching of printing process and paste
  - Prototype or small series production
  - Assembly and test of complete cells
- Pilot series using the roll-to-roll process including material & process optimization to increase cell performance and process reliability
- Process integration, profitability studies and know-how transfer

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