ADVANCED BATTERY CELL DEVELOPMENT AND PRODUCTION
BETTER FOR ANY APPLICATION - SPECIALITIES IN SERIES

Customized cell solutions - Made in Germany
www.customcells.org
CUSTOMCELLS® IS A LEADING BATTERY TECHNOLOGY PROVIDER AND OFFERS SPECIFIC CHEMICAL AND ENGINEERING SERVICES.

CUSTOMCELLS® acts customized to your needs. We have the right experts to help you in all aspects of technical consulting and electrode, cell, energy storage prototyping and mid volume series production. We support you in the technology ramp-up from laboratory to production scale.

POUCH CELLS ARE OUR PASSION!

Our cells are flexible in design, form and chemistry. CUSTOMCELLS® accompanies the way of development and production from material level to battery system.

CUSTOMER HIGHLIGHTS

- 7 of TOP 10 worldwide automotive companies
- 4 of TOP 10 global chemical companies
- 6 of TOP 10 German automotive suppliers
- 6 of TOP 10 German security companies

CUSTOMCELLS® AT A GLANCE

- >100 employees
- 4 customers supported to set up own facility
- 18 years technology background
- >600 companies are customers base
- >1.400 projects team experience
- 14 electrode technologies industrialized
CONSULTING AND SERVICE

PORTFOLIO

CHEMICAL SERVICES

With you we improve and develop an individual recipe also based on your raw materials. We conduct objective benchmarking studies, understand your development challenges and therefore accelerate your market entry.

ENGINEERING SERVICES

We design, prototype and manufacture battery systems with and without cooling systems based on thermodynamic simulations. For BMS (hard- and software) systems we can rely on our partner network.

CONSULTING SERVICES

CUSTOMCELLS® experts create market analysis and feasibility studies as well as material consulting and technology benchmarking. For pricing and competitor analysis we are in a close partnership with P3 group.

SEMINARS & PRACTICAL TRAININGS

In our seminars we follow your demands. We offer different target groups and individual expert level workshops. Our main focus is concentrated on our production insight.

We also offer:

- Performance, environmental and aging tests
- Post-mortem analysis
- Customized electrolyte development and production

We also offer:

- Process and factory simulation
- Technical re-construction, critical design review
- General CAD construction, FEM, renderings
- Module and pack design and construction

We also offer:

- Technology licensing
- Supply chain optimization
- Expert in-house consulting
- Process / yield optimization
- Technology & process consulting
The lithium-ion battery market is growing with growth rates of more than 20% p.a.. Especially for the further increase of the energy density and intrinsic safety at cell level as well as the introduction of new cell chemistries, new materials are mandatory. Our battery experts support you objectively in important questions such as:

- What are the current market requirements and needs?
- Does the material suit the sophisticated lithium-ion battery market?
- Does the material offer unique selling points to provide a competitive advantage compared to the state-of-the-art materials?
- What are the prospects of returns for the market entry?

**BENCHMARKING - FROM LAB SCALE TO PILOT PRODUCTION**

We can benchmark your materials at every stage of the production process and guide you to a successful market entry.

- Material characterization
- Slurry recipe
- Electrode coating
PRODUCTION INSIGHTS WORKSHOP

KNOWLEDGE TRANSFER & LITHIUM-ION CELL MANUFACTURING

CUSTOMER FOCUSED WORKSHOP

In this training you receive all important informations about manufacturing lithium-ion cells and it will give you a deep understanding of the battery market. Experts in the field of cell prototyping and design will give a wide view on specifications and follow your demands. Your questions will be answered in our workshops.

CONTENTS

In addition to the theoretical scope in lithium-ion technology, the construction of cells is carried out in practical courses (depending on the workshop level). You will learn how the individual components of a cell are produced, their behaviour and properties and learn first-hand the production steps from raw materials to the finished cells.

INFORMATION ABOUT CUSTOMIZING LITHIUM-ION CELLS

- Battery market overview
- All theoretical aspects from raw material to lithium-ion cell
- Deep understanding of cell production processes
- Customer focused workshop

PRACTICAL BATTERY TRAINING

- Electrode coating
- Pouch cell stacking and cell assembly
- Slurry mixing and recipe creation
- Automated manufacturing line

BASIC

Basic knowledge-transfer especially tailored for the later discussion on cell specifications.

MEDIUM

Get an insight in the state-of-the-art production of commercial lithium-ion pouch cells.

ADVANCED

Get a detailed insight in the state-of-the-art production process of commercial lithium-ion pouch cells.

EXPERT

Customer specific theory and detailed insight in the development and production process of tailored lithium-ion pouch cells.
LEADING MANUFACTURER
OF CUSTOM-BUILT CELLS

- About 250 raw materials on stock for short reaction time
- 14 electrode technologies industrialized
- Worldwide supplier network for state-of-the-art raw materials
- Superior grades in purity and excellent quality on electrodes
- CUSTOMCELLS’ expertise is the in-depth understanding of raw materials characteristics

We are a trusted partner to our customers in selecting the best materials for their requirements.

RAW MATERIAL

**Cathodes**
- NMC 111 / 532 / 622 / 811,
- LFP, NCA, LFMP, LMNO,
- LCO, LMO, Water-based

**Anodes**
- C,
- LTO,
- SiC

**Inactive materials**
- Substrates, conductive, agents, binders, additives
CUSTOMCELLS® produces various electrodes with superior performance. We are also recognized worldwide as a trustable partner in contract coating and electrode supply based on our or your own chemistries and recipes. Our production plant offers numerous mixing machines from 1 liter up to 200 liters, supreme coating equipment from batch coating up to reel-to-reel processes for serial production. Area capacities and weights are adjustable. The electrode foils are in a wide portfolio of active materials. They are adjustable in calendering grades, coating width and slitting. Our portfolio is also based on modern water based solvents. Our coating facility offers various coating heads as slot die or doctor blade.

Mathis and CUSTOMCELLS® have worked together for many years allowing CUSTOMCELLS® to provide the best coating and drying technology and therefore flexible design for its battery design.

Clemens Disch
Werner Mathis AG, Coating and Textile Machinery

- Coating width up to 450 mm
- Throughput 20 MWh/p.a.
- Different dispersers
  1 / 20 / 50 / 200 liter
ELECTRODE COINS & SHEETS

HIGH QUALITY ELECTRODE SHEETS SAVE YOU UP TO 49% R&D COST

The electrode sheet product line provides all modern active materials and fulfil the gap between the half cell and the full cell. High quality electrodes and consistent electrode compositions are mandatory to be successful in material cell development.

- The wide tab area allows even the fast set up of multilayer cells
- Reduces equipment costs
- Less machine hours, faster results

READY-TO-USE ELECTRODE COINS SAVE YOUR TIME AND EFFORT

CUSTOMCELLS® electrode coins are optimized for EL-CELL electrochemical test equipment. The electrode coins allow professional researchers a fast and precise workflow at low costs. Electrode coins are provided ready-to-use in inert atmosphere packaging. This will save you effort, time and cost.

- Fully standardized in 13 & 18 mm diameter
- Prepared and optimized for half and full cell testing
- Simple glovebox handling due to single packaging
- Pre-dried and sealed in inert gas atmosphere

CUTTING & CALENDERING

Cell design
Mechanical punching & laser cutting
Flexible in calendering grades
INDIVIDUALIZED MULTI-OPTION CELLS BY CUSTOMCELLS®

While standard cells only feature standard performance, CUSTOMCELLS® offers individualized multi-option cells suiting exactly to your application. Electrodes based on future materials, high safety configurations and unrivaled performance make these cells perfect to suit even the roughest applications.

CHOOSE AMONG THESE POSSIBLE SPECIFICATIONS

- **Capacity** up to 350 Ah
- **Standard and tailored electrolytes**
- **Ultra-high energy densities** over 300 Wh/kg or 850 Wh/L
- **Highly safe technologies**
- **High power rates** over 20 C
- **Usage of future materials with 250 different raw materials on stock**
- **Low internal resistance and fast charging ability**
- **Temperature resistance from -40 °C to 150 °C**

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**CELL ASSEMBLY**
- Pouch forming
- Tab welding
- Packaging and filling

**FORMATION & TESTING**
- Adapted formation for each cell chemistry
- Individual testing protocols
- Rate capability, cycle life, impedance, SOC
- Measurement of evolving heat during cycling
CUSTOMCELLS® ELECTROLYTES AND ELECTROLYTE DEVELOPMENT

The growing global demand for lithium-ion batteries and the high technical demands for energy, power density and service life are continuously leading to the development of new electrode materials. A prerequisite for compatible use of cell components is the use of tailor-made electrolytes. CUSTOMCELLS® draws on know-how developed over many years and numerous patents relating to battery electrolytes and is thus able to provide a finished electrolyte within a very short time. CUSTOMCELLS® also meets individual customer requirements, e.g. the use of battery cells in high and low temperature ranges, within the framework of electrolyte development with complete solutions. If required, CUSTOMCELLS® will develop a suitable electrolyte specifically for your application.

DEVELOPMENT OF TREND-SETTING ELECTROLYTES

CUSTOMCELLS® participates in E-Lyte Innovations GmbH in the field of electrolyte development. Founded in May 2019, the company develops, optimizes and markets application-specific ready-to-use electrolytes and electrolyte components for lithium-ion batteries. The focus is on the optimization and production of electrolytes according to special customer requirements. CUSTOMCELLS® guarantees the safe, fast, efficient provision of solutions based on the highest level of know-how in order to develop individual customer requirements and the specific requirements of their battery systems in a result-oriented manner.
CUSTOMCELLS SERIES PRODUCTION

HIGH-QUALITY APPLICATION-SPECIFIC SERIES PRODUCTION

We operate one of Europe’s most modern cell production lines at our CUSTOMCELLS® site in Tübingen. We offer our customers series production of lithium-ion pouch cells at the highest technological level. We supply quality ‘made in Germany’. The use of state-of-the-art laser technology affords us the highest degree of flexibility. Our customers are faced with challenges – with our expertise and our technology, we make the right suggestions and give them the ideal solutions. We manufacture customised battery cells in small and medium-sized batches. The special application area is standard to us.

ADVANCED BATTERY CELL PRODUCTION - MADE IN GERMANY

- State-of-the-art series production
- Modern cell production in Germany
- High-quality lithium-ion batteries
- Long-standing expertise
- Small and medium-sized batches
- Cells in individual formats and shapes
- Automatic fault part detection
- 100% In-line and offline testing
- Statistical evaluation of the data
- Gentle material handling
- Quality and technology-oriented cells
- Flexible production environments

OPTIMIZATION TOWARDS HIGH ENERGY - TECHNOLOGY EXAMPLE

Optimized Electrode formulation - Cathode: NMC-811 - Anode: Si-C

NMC-811 is the latest cathode development. This material shows 12% more specific capacity than NMC-622 and an improved rate capability. Due to the reduction in cobalt content, NMC-811 is more economic than all other current cathode materials.
Are you looking for a new challenge? CUSTOMCELLS® offers you an attractive working environment with challenging projects. With our team of more than 100 employees, we are one of the world’s leading companies in the field of special lithium-ion accumulator technologies. Please find our current job offers on www.customcells.org/career.
CUSTOMCELLS® offers cell assembly based on components provided by the customer. Would you like to evaluate your cell component in the overall battery cell system? CUSTOMCELLS® also uses individual components provided by the customer as part of the cell assembly and, by optimally supplementing the other components, delivers a battery cell defined according to the customer’s requirement profile.

At first glance, lithium-ion battery cells only consist of a positive electrode, a negative electrode, a separator and an electrolyte. However, the actual construction of a lithium-ion battery cell is much more complicated and the increasing number of components and the emergence of new electrode active materials in modern lithium-ion battery cells require a great deal of know-how and practical experience to understand the interactions of the components and their effects on cyclical cell aging, internal resistance or other key performance indicators (KPIs).

From the evaluation of new materials and new cell components, essential strategies for cell development and cell assembly can be derived, which is the key to high-performance and durable lithium-ion battery cells. For this purpose, however, it is essential that the investigations of new components are based on absolutely reproducible processes.

FITTING YOUR INDIVIDUAL REQUIREMENTS

The battery cell experts at CUSTOMCELLS® respond directly to the customer’s individual requirements and select the other cell components depending on the target application or target market.
CUSTOMIZED BATTERY SYSTEM PROTOTYPES AND LOW VOLUME SERIES

- Innovative cooling concepts and high safety battery systems
- Lightweight construction and integrated design
- Customer specific adaption of battery system to space requirements and operational conditions
- Strategic partners for complex BMS development, pack construction and charging infrastructure
- Whole optimization beginning from raw materials to the final battery system

COMPETENCE IN CUSTOMIZED BATTERY SYSTEMS

- Subsea pressure neutral battery systems
- Aerospace battery systems
- AUV and drone battery systems
- UAV and ROV battery systems
- High performance EV battery systems
- Medical battery systems
## PORTFOLIO OF ELECTRODES

<table>
<thead>
<tr>
<th>Active material</th>
<th>Specific capacity</th>
<th>Safety</th>
<th>Special features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium-Manganese-Oxide LMO</td>
<td>110 mAh/g</td>
<td></td>
<td>High operation potential, good rate capability</td>
</tr>
<tr>
<td>Lithium-Nickel-Manganese-Oxide LNMO</td>
<td>110 mAh/g</td>
<td></td>
<td>High voltage spinell (5V), low stability, special electrolyte required</td>
</tr>
<tr>
<td>Lithium-Iron-Phosphate LFP</td>
<td>150 mAh/g</td>
<td></td>
<td>Nontoxic, but low operation potential</td>
</tr>
<tr>
<td>Lithium-Iron-Manganese-Phosphate LFMP</td>
<td>150 mAh/g</td>
<td></td>
<td>NEW, higher potential, than LFP, cobalt free</td>
</tr>
<tr>
<td>Lithium-Nickel-Manganese-Cobalt-Oxide NMC-111</td>
<td>150 mAh/g</td>
<td></td>
<td>First generation NMC material, medium capacity</td>
</tr>
<tr>
<td>Lithium-Nickel-Manganese-Cobalt-Oxide NMC-532</td>
<td>155 mAh/g</td>
<td></td>
<td>Higher capacity and slightly reduced safety compared to NMC-111</td>
</tr>
<tr>
<td>Lithium-Nickel-Manganese-Cobalt-Oxide NMC-622</td>
<td>160 mAh/g</td>
<td></td>
<td>State-of-the-art NMC material, reduced cobalt content</td>
</tr>
<tr>
<td>Lithium-Cobalt-Oxide LCO</td>
<td>160 mAh/g</td>
<td></td>
<td>State-of-the-art material for power electronics</td>
</tr>
<tr>
<td>Lithium-Nickel-Cobalt-Aluminium-Oxide NCA</td>
<td>170 mAh/g</td>
<td></td>
<td>High energy material</td>
</tr>
<tr>
<td>Lithium-Nickel-Manganese-Cobalt-Oxide NMC-811</td>
<td>175 mAh/g</td>
<td></td>
<td>High energy, nickel rich NMC, lower stability</td>
</tr>
</tbody>
</table>

### ANODES

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<tr>
<th>Active material</th>
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<th>Safety</th>
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</tr>
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<tbody>
<tr>
<td>Lithium-Titanium-Oxide LTO</td>
<td>150 mAh/g</td>
<td></td>
<td>Long cycle life, high rate capability</td>
</tr>
<tr>
<td>Graphite C</td>
<td>350 mAh/g</td>
<td></td>
<td>State-of-the art material</td>
</tr>
<tr>
<td>Silicon-Graphite SIC</td>
<td>400 - 1000 mAh/g</td>
<td></td>
<td>Different silicon contents available</td>
</tr>
</tbody>
</table>

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BETTER FOR ANY APPLICATION
SPECIALITIES IN SERIES

FITTING YOUR APPLICATION
+ High C-rates / ultra high energy densities
+ Cell designs in individual formats and shapes
+ Tailormade cell chemistries / future materials
+ Low internal resistance and fast charging ability
+ Temperature resistance from -40° up to 150° C

ADAPTABLE IN TECHNOLOGY
+ Medical industry: Autoclavable
+ Aviation: Lightweight optimized
+ Maritime industry: Safe and robust
+ Automotive industry: Fast charging capacities
+ Power and handheld tools: Full design flexibility

ADVANCED BATTERY CELL DEVELOPMENT AND PRODUCTION

Customized cell solutions - Made in Germany
POWERED BY PEOPLE

CONSULTING - CELL DESIGN
CELL DEVELOPMENT - PROTOTYPING

INDUSTRIALIZATION OF
DEVELOPED CELL CONCEPTS

MICROFACTORY AND
HIGH PRECISION SERIES PRODUCTION

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