Experiences in prototyping of Li-Ion cells for automotive applications

Dr. Andreas Huth
VW-VM Forschungsgesellschaft

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Agenda

➢ Introduction
➢ VW-VM facts
➢ Success factors
➢ Learnings and experiences
➢ Conclusion
Cooperation between
VOLKSWAGEN AG – VARTA Microbattery GmbH

Target
Development of a competitive Li-Ion Single Cell for automotive applications

VW-VM
Forschungsgesellschaft mbH & Co KG

Partner
VOLKSWAGEN
AKTIENGESELLSCHAFT

VARTA
Targets

- Research on chemistry for PHEV and BEV
- Cell manufacturing Pouch, Hardcase
- Safety tests
- Electrical Tests

Specific Energy Density [Wh/kg]

Specific Performance Density [W/kg]

High Energy Cells
- Ni-rich NMC
- HV-Spinell
- Li-rich NMC

High Power Cells
- Ni-rich NMC
- HV-Spinell
- Li-rich NMC

Status of actual cells
- C // NMC-111

Huth presentation AABC europe
Material of VW-VM Forschungsgesellschaft mbH & Co KG
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31.01.2017
## Battery Formats

<table>
<thead>
<tr>
<th>Research Lab Cells</th>
<th>Research Test Cells</th>
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<tbody>
<tr>
<td><strong>05 35 62</strong></td>
<td><strong>PHEV2</strong></td>
</tr>
<tr>
<td>- 0.030-0.060 Ah</td>
<td>- &gt; 37 Ah</td>
</tr>
<tr>
<td>- Stack</td>
<td>- prismatic jelly roll, stacks</td>
</tr>
<tr>
<td>- Pouch</td>
<td>- Alu case</td>
</tr>
<tr>
<td><strong>50 35 62</strong></td>
<td><strong>116 105 3015</strong></td>
</tr>
<tr>
<td>- 0.560-0.900 Ah</td>
<td>- &gt; 45 Ah</td>
</tr>
<tr>
<td>- Prismatic jelly roll</td>
<td>- Stack</td>
</tr>
<tr>
<td>- Pouch</td>
<td>- Pouch</td>
</tr>
<tr>
<td><strong>18 650</strong></td>
<td></td>
</tr>
<tr>
<td>- ca. 1,700 Ah</td>
<td></td>
</tr>
<tr>
<td>- Jelly roll</td>
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<tr>
<td>- Steel case</td>
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Facts and Figures

Research Lab Cells < 5 Ah
3,400 Tests built
48,700 Cells built
24,500 Tests conducted

Research Test Cells 30-40 Ah
590 Test built
8,900 Cells built
5,000 Tests conducted

Research Projects
- LiMo, LiSta
- Li-NaS, Li-FeM
- BASTA
- LiSSi
- SafeBatt

Material Supplier
Machine Supplier
University
Services
Production
Pilot Production Equipment

- Industrial, serial alike production processes
- All production steps available
- Capacity 50 PVEH2-cells per day

Extensive test equipment available
Overview
Location Ellwangen

Testlab 268 m²

Production 1.133 m²
Cell Assembly

Office 103 m²

Production Area 1.050 m²
Electrode manufacturing, Formation, Performance testing
Key factors

✓ Passion
✓ Precision
✓ Experience
✓ Respect
✓ High competence in all value added steps
### Process Steps Winding

<table>
<thead>
<tr>
<th>Slurry mixing</th>
<th>Electrode coating</th>
<th>Electrode calendering</th>
<th>Electrode slitting</th>
<th>Electrode winding</th>
<th>Lid assembling</th>
</tr>
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<tr>
<th>Cup assembling</th>
<th>Jelly roll welding</th>
<th>Jelly roll drying</th>
<th>Jelly roll assembling</th>
<th>Lid welding</th>
<th>Electrolyte filling</th>
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<tr>
<th>Tempering</th>
<th>Formation</th>
<th>Electrolyte filling</th>
<th>Sealing</th>
<th>Annealing</th>
<th>Performance testing</th>
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Slurry manufacturing

- Slurries made of active material with particle sizes 0.4 µm – 20 µm
- Homogenous appearance compulsory
- Reproducible adjustment of final viscosity by 100 mPas required
Electrode manufacturing

- Coating tolerance of +/- 1,5 mass% required
- Accuracy of wet film thickness variation by +/-1µm
- Coating tolerances close to detection limit due to variation of foil weight
Roll pressing

- Roll pressing of continuous and intermittent coated electrodes
- Final tolerances of ±1 μm reached
- High effort to keep the electrode in shape even with uncoated rim
Slitting

- Slitting of a high variation of materials (metal foils, separator material, electrode material)
- Direct influence on single cell capacity
- Symmetrical slit
Winding process

- Patented manufacturing process with in-situ-cut tab areas
- Laser cutting process requires high effort in guiding electrode tapes
- Core design in order to keep the pressure constant along the peripheral line
Laser welding

- Laser welding and cutting core equipment for prototyping
- Joining zone minimize pin holes and splatters
- Joining up to 100 layers of copper and aluminum foil, limiting heat impact required
Summary

✓ Successful research activities
✓ Identification of success factors
✓ Optimization of value added chain
✓ Modification of all machines, equipment and systems with respect to high accuracy and high quality requirements of battery manufacturing
Thank you for your interest!