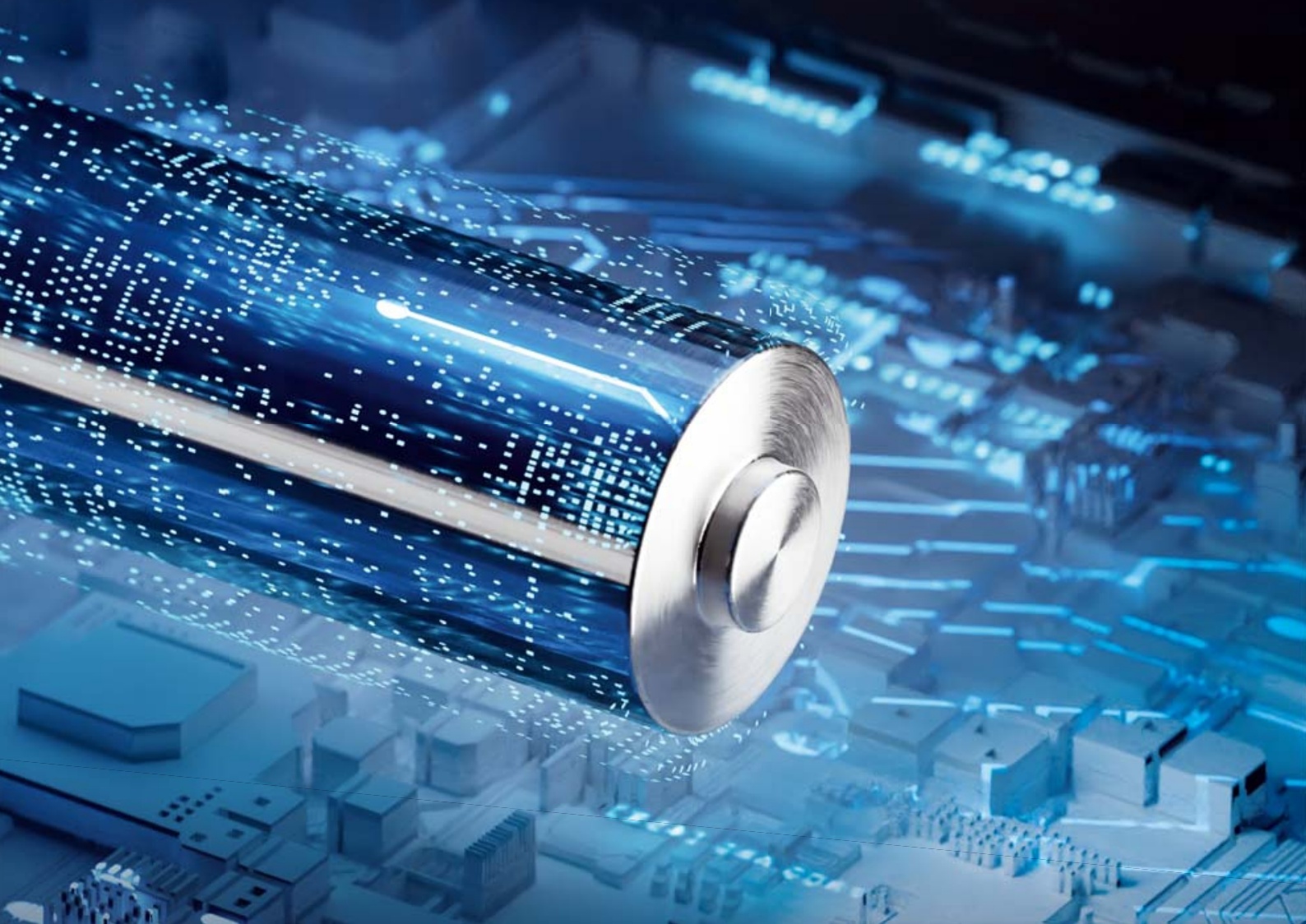


INNOVATIVE SOLUTIONS FOR THE ENTIRE PROCESS CHAIN

EFFICIENT PRODUCTION OF BATTERY MASSES



zeppelin-systems.com

 **ZEPPELIN**[®]
WE CREATE SOLUTIONS



METICULOUS HANDLING OF RAW MATERIAL IS CRITICAL

PROCESS EXPERTISE THAT SETS NEW STANDARDS

Whether using wet or dry processes, production of battery mass is challenging. After all, the raw materials for producing battery masses have not only very diverse characteristics, but also special requirements, and must be processed reliably and with precision.

As an international plant engineer with decades of experience, Zeppelin Systems is very familiar with the specific customer requirements in the battery sector. Using special mixers and individual conveying and storage concepts, Zeppelin Systems develops customized concepts and systems at the highest level.

The customer advantage here is clear: Zeppelin Systems' technical departments can carry out in-house laboratory testing on the properties and behavior of the raw materials. In addition, there are various testing possibilities available to ensure the operational success of the components or complete system solution. Thanks to Zeppelin Systems' global site management, we can offer you our comprehensive service for your components and systems worldwide. And always flexibly adapted to your customer needs!

EXPERTISE FROM A TO Z

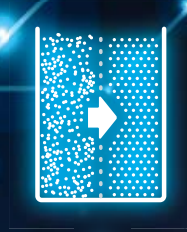
Zeppelin Systems represents the first step of the "battery production" process chain. From receiving the material, whether in raw form or as recycle, to conveying and storage, to the mixing process and dosing into the calender. As such our system concepts offer optimal preconditions for the handling of sensitive substances and the important mixing process – all from one source.

We Create Solutions!





**PRECISE DOSING
AND WEIGHING**



**EFFICIENT
MIXING**



**FURTHER
PROCESSING**

MATERIAL SUPPLY, STORAGE AND CONVEYING

WE HANDLE EACH RAW MATERIAL ON A CUSTOMIZED BASIS

The safe supply and storage of raw materials (and intermediate products) plays an essential role in battery mass production. Zeppelin Systems takes into account the specific properties of the raw materials – including abrasives – and designs systems in accordance with locally applicable guidelines (e.g. ATEX in the EU, NFPA in the USA and KCs in South Korea). In addition, containment concepts which are carefully tailored to the respective hazard classes ensure that employees and the environment are not unnecessarily burdened by partially toxic raw or intermediate products.

ECONOMICAL, SAFE AND PRODUCT-FRIENDLY

The properties of the raw materials and mixtures, the planned production quantities and processes are important parameters for the concept of the overall system to be created. Investment costs and subsequent operating costs are added. Based on these parameters – which some-

times heavily influence each other – Zeppelin Systems develops an optimal system for customers which encompasses safe handling, gentle pneumatic conveying and perfect mixing. This means tailor-made solutions with maximum (process) reliability and cost-effectiveness.

PROCESS REQUIREMENTS →
PRODUCT PROPERTIES →
CONVEYING SERVICES →
REMOVALS →



← ENERGY EFFICIENCY
← QUALITY/RELIABILITY
← ENVIRONMENTAL PARAMETERS
← INVESTMENT AND OPERATING COSTS

DOSING AND WEIGHING

PRECISION FOR MAXIMUM PERFORMANCE

Seamless traceability of the raw materials used, comprehensive monitoring of the process parameters, as well as precise and correct dosing and weighing of all raw materials according to recipe specifications are essential for the quality of the resulting electrode mass and battery cell. Ultimately, this is decisive for the performance and longevity of the battery cell to be built.

HIGHEST PRODUCT PURITY

Zeppelin Systems' dosing systems, augers and scales are designed to meet maximum customer requirements in terms of accuracy, production and maintenance needs, and operating conditions. When doing this, the focus is always on ensuring that the individual raw materials are dosed into the mixer with the desired precision and then discharged reliably.





MIXING

MIXING BATTERY MASSES MORE INNOVATIVELY

Zeppelin Systems combines many years of engineering experience with process expertise and technical know-how, from conceptual design to construction and production of industrial mixers. The result: The FM high-performance intensive mixer for battery masses. This mixer is ideal for use in raw material preparation; for premixing, for the very fine distribution of additives / conductive additives (e.g. Carbon Black or Carbon Nano Tubes) with other substances, or for the production of battery masses using the dry and semi-dry processes.



EXTREMELY HIGH SHEAR RATES

Extremely high shear rates are achieved due to the high speeds, the design of the mixing tool and the construction of the mixing tank. This facilitates highly efficient dispersion and homogenization of the raw materials. Making the mixer ideal for reproducible and reliable production of battery masses in dry and semidry mixing processes.

PERFECTLY ADAPTED TO THE MATERIALS

By means of various process parameters (e.g. individual shear rates, precisely regulated temperature profiles, etc.), it is possible to effectively disperse and finely distribute partly nanoparticulate conductive additives, to activate binder materials in a targeted way, and to fibrillate them. Furthermore, increased bulk density and energy density can be achieved through targeted alteration of the particle structure. The FM intensive mixer from Zeppelin Systems additionally offers customized wear protection, which also ensures a long service life in spite of the abrasive raw materials used in battery production.

ZEPPELIN SYSTEMS TESTING CENTERS

TEST PROCESSES – FOR OPTIMAL PRODUCTION PROCEDURES

Zeppelin Systems operates three testing centers in which process-critical processing steps can be tested and improved. Both the mixing and plant technology, as well as the mixing process itself, can be thoroughly tested and optimized here. Some of our testing is directly carried out at industrial scale. This avoids uncertainties during scale-up.

TEST SERIES FOR BATTERY MATERIALS

In our testing center for mixing technology in Kassel for example, processes are tested and further developed up to production scale, on individually configurable laboratory mixers. Test series have already been carried out for various AAMs (anode active materials) and CAMs (cathode active materials). The test series involved LFP, NCA, NMC, SiC, SiO_x, as well as a wide variety of graphites and binders, with and for renowned customers in the industry and international research institutions.

HOW DO THE DIFFERENT RAW MATERIALS BEHAVE?

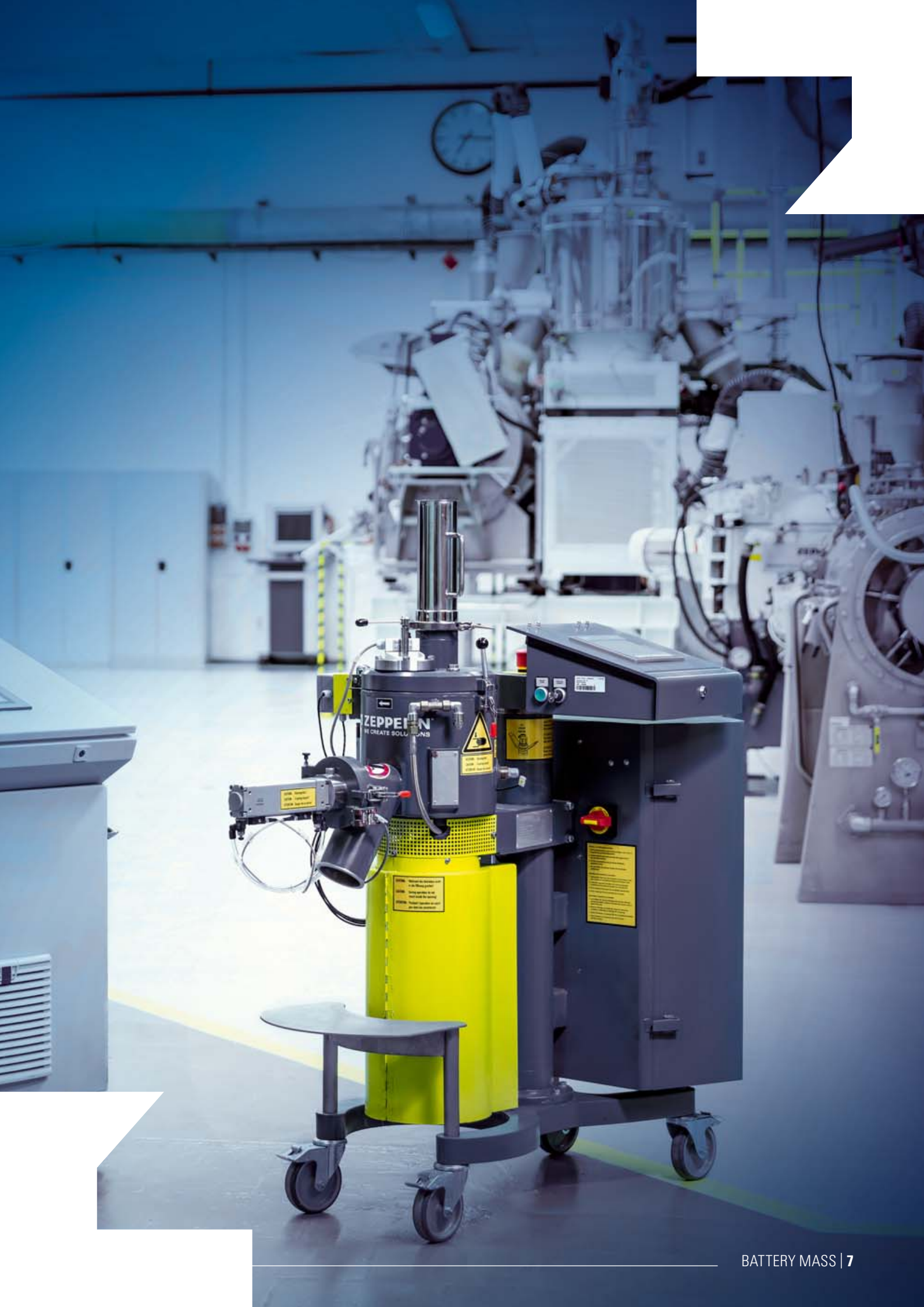
At the testing center in Friedrichshafen, it is possible to examine the behavior of a huge variety of raw materials in terms of conveyability, fluidizability, hardening over time, discharge behavior, product and/or particle alteration, etc. A separate test setup is currently being especially created here to facilitate testing of calender dosing of various AAM and CAM mixes for Zeppelin Systems customers.

In addition, a wide range of product analyses are carried out in the company's own bulk material laboratory, including moisture measurement, particle size and distribution, determination of bulk density and shear tests, etc. For reliable, sustainable battery mass production.

We Create Solutions!

CALENDER DOSING INNOVATION

In addition to raw material handling, we also focus on optimizing production processes – such as calender dosing. In order to ensure continuous and precise dosing to the rollers, our engineers have developed their own solution here. Our dosing unit for the calender is equipped with a continuous material supply with level monitoring in the hopper – which means that the calender rollers cannot run empty. The hopper is directly coupled to a calender roller and can be moved in a linear fashion. The special geometry of the hopper prevents bridge formation and significantly reduces the line load on the rollers.



ZEPPELIN
RECHARGE SOLUTIONS



Zeppelin Systems GmbH

Performance materials
Graf-Zeppelin-Platz 1
88045 Friedrichshafen
Germany

Phone +49 7541 202 - 1414
systems.support@zeppelin.com

zeppelin-systems.com