

VISION IN BATTERY CELL MANUFACTURING

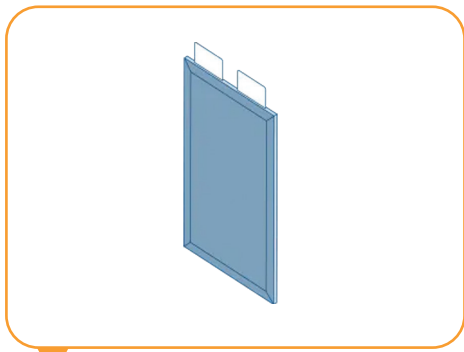


Machine vision allows quality control

In the production of battery cells, high quality in all process steps and the reduction of material waste are crucial. Digital image processing enables the reliable detection of even the smallest defects. Our solutions help to produce safe, high-quality battery cells to meet the challenges of electric mobility.

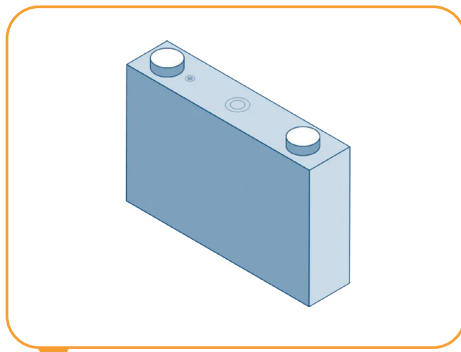
Different cell types

The main application for lithium-ion battery packs is electric mobility. There are three types and formats in use. The functional principle of all types is essentially the same. The main differences are in design, requirements and materials used.



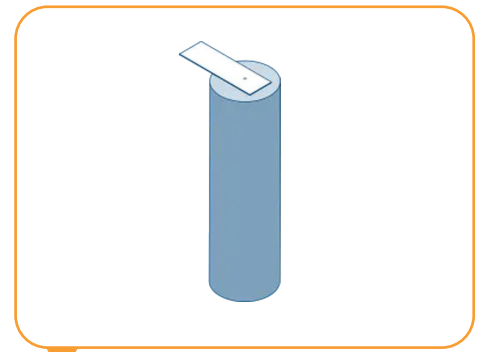
Pouch cell

The geometry of the pouch cell is almost arbitrary and the size is easily scalable. The free positioning of the cell arresters and the electrode stacking—anode on cathode, divided by a separator—allow good heat dissipation and simple energy management.



Prismatic cell

The prismatic cell also consists of stacked anodes and cathode packages. The fixed metal housing provides advantages when assembling the cells into a module. The prismatic cell combines high energy density with safety and long lifetime.



Cylindrical cell

The cylindrical cell is a proven technology in battery manufacturing. Cylindrical cells consist of an anode and a cathode separated by a separator and wound into a roll. The round design results in a loss of space at the battery pack module level.

VISION IN BATTERY CELL MANUFACTURING

MOST POPULAR PRODUCTS



VisualApplets

With VisualApplets the programming of FPGAs on a graphical user interface succeeds completely without hardware programming.



pylon vTools for Image Processing

Quickly and easily design functions like intelligent structure recognition, micrometer-precise object positioning, or robust code recognition. Flexibly integrate everything you need into your own application.



Frame grabbers

These boards provide robust, high-speed image acquisition and processing, as well as signal control. The FPGA processors ensure real-time processing.



Line scan cameras

We offer line scan cameras with different resolutions, interfaces, and data rates—providing better quality assurance and sorting processes.



Basler boost area scan camera

The Basler boost camera series combines the latest CMOS sensor technology with high bandwidths and all the other advantages of the CoaXPress 2.0 standard.



Basler ace 2 area scan camera

The ace 2 is available with different sensors suitable for multiple wavelength ranges and your choice of USB 3.0, GigE, or 5GigE interface.



ace 2X visSWIR

Basler Short Wavelength Infrared cameras offer state-of-the-art SWIR technology with your choice of resolution and USB 3.0 or GigE interface.



ace 2 X UV camera

Basler ultraviolet cameras offer state-of-the-art UV technology with USB 3.0, GigE, or 5GigE interface.

USE CASE: QUALITY INSPECTION DURING COATING

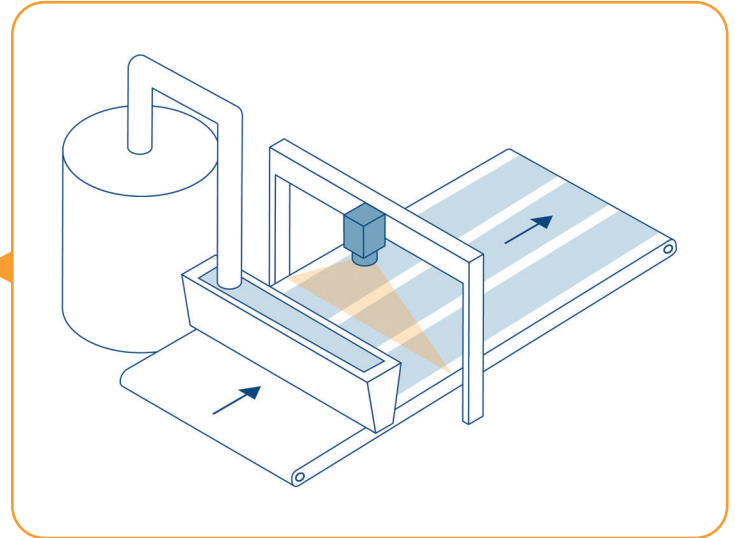
DESCRIPTION OF USE CASE

Quality Control in Electrode Coating (Battery Cell Manufacturing)

Machine vision detects particles and voids with large amounts of data.

Coating the substrate foil with slurry is a critical production step. The surface quality must be uniform, free of voids and particles, and the thickness of the slurry must be precise and homogeneous.

Our vision technology can handle the high speed of this process step, helping to significantly reduce material waste.



Electrode coating in detail

In electrode coating, the carrier or substrate foil is coated with the previously mixed slurry using an application tool such as a slot die, doctor blade, or anilox roller.

The top and bottom sides of the foil can be coated in parallel or sequentially. This is followed by a drying process.

A correctly applied electrode layer has a decisive influence on battery performance

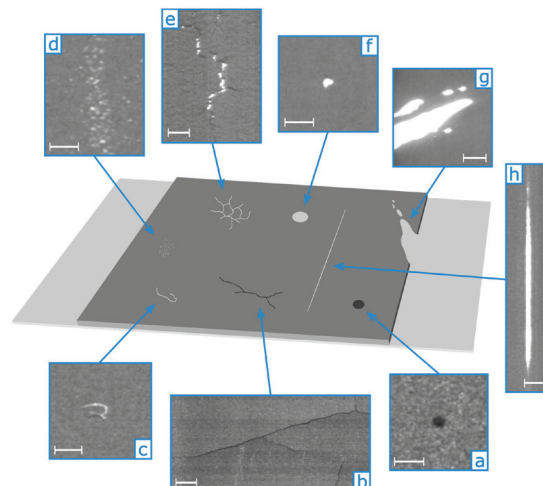
This process step is particularly critical because many parameters must be precisely coordinated: The slurry must have the required stability and be applied at the correct rate. The aim is to achieve perfect coating homogeneity without cracks or agglomerates, as the electrode layer is particularly important for battery performance.

Possible defects in slurry application

Defects can occur in both intermittent and continuous electrode coating. They depend on the viscosity of the slurry and the accuracy of the dispenser.

Typical defects are:

- a. Agglomerate
- b. Coating crack
- c. Contamination
- d. Micro-compression
- e. Mud crack
- f. Pinhole
- g. Slip or
- h. Stripe



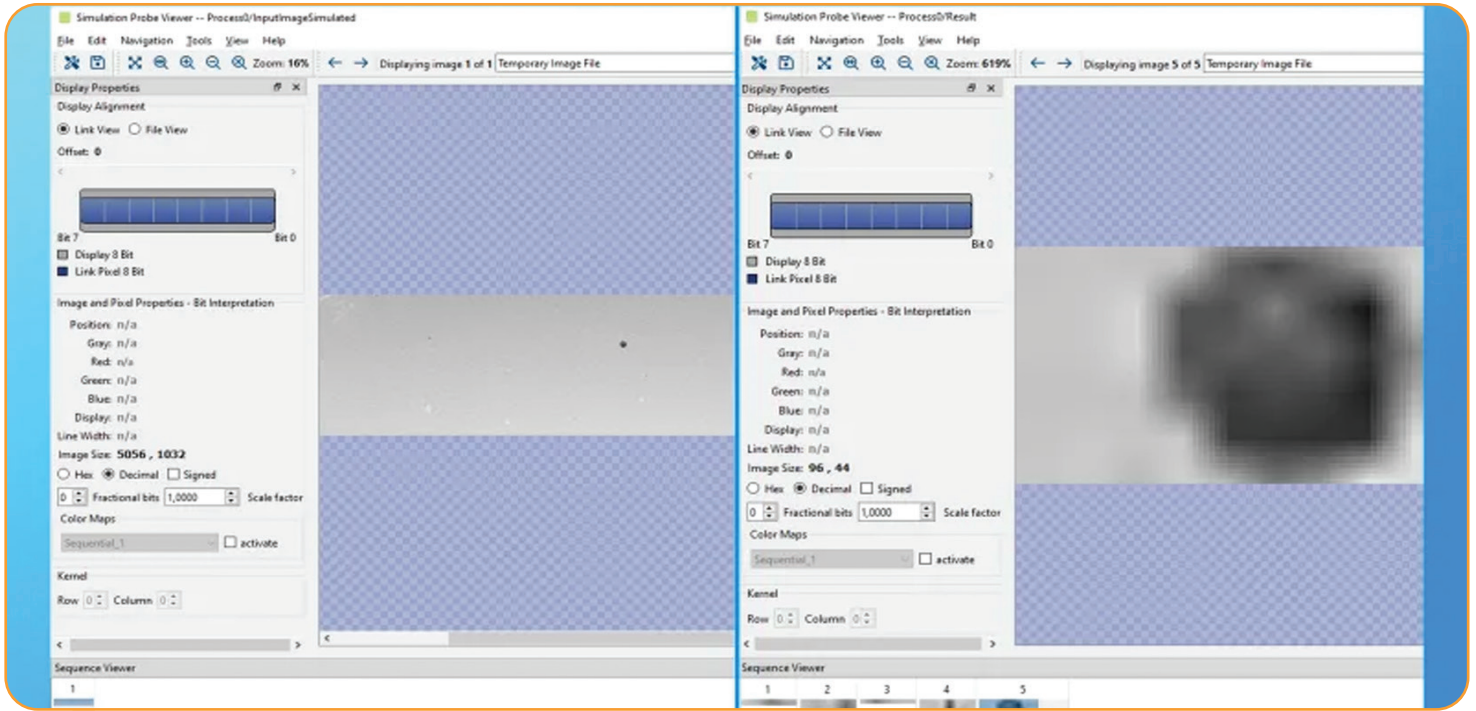
Types of defects in electrode production. Scale: 1 mm. Source: Schoo A, Moschner R, Hülsmann J, Kwade A. Coating Defects of Lithium-Ion Battery Electrodes (...). Batteries. 2023; 9(2):111. - <https://doi.org/10.3390/batteries9020111>

USE CASE: QUALITY INSPECTION DURING COATING

DESCRIPTION OF USE CASE

Production speeds of up to 80 m/min and high detail accuracy

Image processing in the production process presents a dual challenge: very high production speeds, which generate large amounts of image data. At the same time, a high level of detail is required, which is achieved through high image resolutions and generates even larger amounts of data. Conventional solutions generally do not have the processing power required.

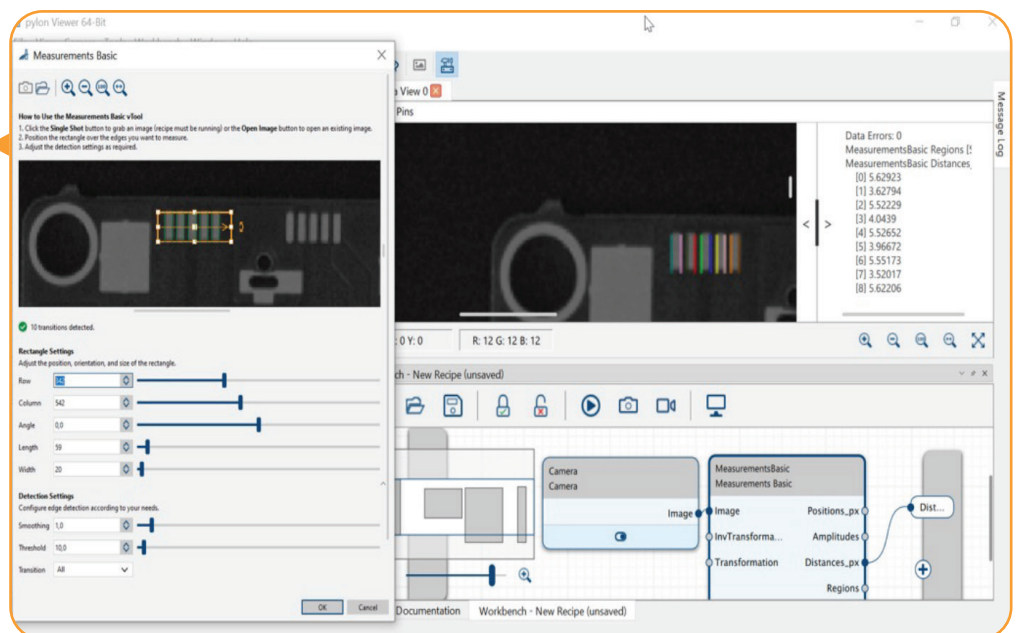


Left: Electrode coating with defects in full image size (5,056 px x 1,032 px). Right: ROI of a single defect with only 96 px x 44 px. Only a fraction of the data needs to be analyzed thanks to image pre-processing.

The high-sensitivity line scan cameras in our racer and racer 2 series are designed for web material. They deliver the required throughput and image quality. A combination of the Basler VisualApplerts software and a frame grabber pre-processes the image data and creates the necessary focus for the actual image processing. By determining the region of interest (ROI), only the areas with irregularities are localized. Only the image data from the ROI is processed. This has the advantage that the CPU of the IPC can continue to be used for the actual system control without any additional load.

Classify defects and make qualified decisions with pylon vTools

The next step is to further analyze the irregularities within the ROI. The Basler pylon vTools software can e.g. classify the type of defect or measure the size of the defect. Depending on the type and size of the defect, a decision is made as to whether the defect is within tolerance or whether further action is required. Accurate localization and measurement allows for precise cutting out of defective areas. This improves the quality of the battery cell and minimizes material waste.



USE CASE: QUALITY INSPECTION DURING COATING

HARDWARE

Camera racer 2L Basler



The r2L8192-200cm Basler racer 2 L camera is equipped with a Gpixel GL7008 sensor (8k).

r2L8192-200cm

| | |
|---------------------------|---|
| Resolution | 8192 x 1 pixels |
| Sensor Type | Gpixel GL7008 Monochrome Linear CMOS Global shutter |
| Sensor Format | 57.34 mm |
| Pixel Size (HxV) | 7 x 7 µm |
| Max. Line Rate | 200 kHz <small>(pixel format set to an 8-bit or 10-bit pixel format and exposure time set to minimum)</small> |
| Mono / Color | Mono |
| Image Data Interface | CoaXPress, 2x CXP-12 (2.5–12.5 Gbps per channel) |
| Pixel Format | Mono8, Mono10, Mono12 |
| Sensor Bit Depth | 12 bit |
| Synchronization | Via hardware trigger Via software trigger Via free run |
| Exposure Time Control | Via hardware trigger Programmable via the camera API |
| Camera Power Requirements | Power over CoaXPress (PoCXP): 24 VDC supplied via the camera's Micro-BNC (HD BNC) connector 19.2-28.8 VDC supplied via I/O connector |
| I/O Lines | 3 differential general purpose I/O (GPIO) lines |
| Lens Mount | M72x0.75-mount |
| Size (L x W x H) | 36 x 80 x 90 mm |
| Weight | ≈650 g |
| Conformity | CE (includes RoHS), FCC, KC, GenICam, CoaXPress 2.0, IP30 |
| Software | Basler pylon Windows (version 7.3 or higher) Basler pylon Linux x86 (64 bit) (version 7.3 or higher) Basler Framegrabber SDK Windows (64 bit) (version 5.11 or higher) Basler Framegrabber SDK Linux x86 (64 bit) (version 5.11 or higher) |

Frame grabber



imaFlex CXP-12 Quad is a fully programmable CXP-12 frame grabber. When connected to the computer power supply, imaFlex CXP-12 Quad supports Power over CXP (PoCXP).

Accessories

Basler offers a range of compatible lenses for our line scan camera portfolio. Schneider Kreuznach insensitive lenses are designed to be used with our line scan camera portfolio under harsh conditions as in many industrial applications. Very low chromatic aberrations plus low geometric distortion provide a very high image quality from edge to edge at a wide magnifications range.

Along with the camera and lenses, a suitable lighting is crucial for producing quality images. Optimizing this image performance enables the analysis of the finest structures and saves processing time in image analysis. Basler offers suitable lighting options for performance systems in industrial settings.

USE CASE: QUALITY INSPECTION DURING COATING

SOFTWARE

Visual Applets

VisualApplets enables FPGA programming using a graphic user interface (GUI) without need of hardware programming experience. With VisualApplets the programming of FPGAs on a graphical user interface succeeds completely without pre-knowledge on hardware programming. The function and ease of the software has earned it several awards. The latest VisualApplets version combines all former standard extensions into a single license to empower your FPGA development.



Highlights

- Access to FPGAs in image processing hardwares
- Implement unique image and signal processing applications
- Create and process complex applications using preconfigured sample applets
- Programmable frame grabbers are available pre-licensed for use with VisualApplets

For more information, please visit baslerweb.com/visualapplets

pylon vTools

Use pylon vTools to quickly and easily create high-performance image processing functions for your applications. Design and test intelligent structure recognition, micrometer-precise object positioning, or robust code recognition and integrate everything into your own application - together with camera control and image acquisition, precisely tailored to Basler's camera portfolio.



Highlights

- Seamlessly integrated image processing with pylon
- High performant and robust
- Precisely matched to Basler cameras
- Easy and fast to create visually
- Easy to integrate into existing architectures
- Cost-optimized module cutting

For more information, please visit baslerweb.com/pylonvtools

Basler AG
Germany, Headquarters
Tel. +49 4102 463 500
sales.europe@baslerweb.com

Please visit our website to find further Basler offices and representatives close to you:
baslerweb.com

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