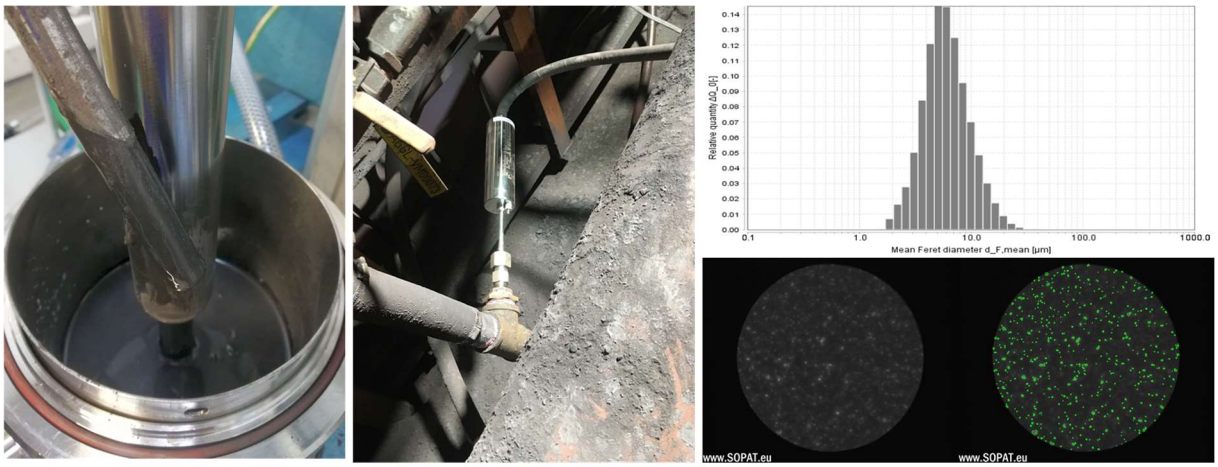
Evaluation of an In-Line particle characterization method for slurries in battery production

Sebastian Maaß, SOPAT GmbH, Berlin, Germany;
Marcel Dittmer, TU-Braunschweig, Braunschweig, Germany

Batteries keep both essentials and comfort of modern life running with safety and reliability. They have a long list of real-world applications – consumer electronics power, Electric Vehicle (EV) power, solar power storage, UPS, alarm systems in remote locations, mobility equipment and portable power packs. Currently, this battery technology is on the verge of carrying the revolution in road transport and energy storage of renewable energy. Battery performance and lifetime constitute a bottleneck for electric vehicles as well as stationary electric energy storage systems to penetrate the market. Design, modeling and simulation of mills, extruders or similar is currently often based on experience and measurements from the laboratory or with the help of laboratory analysis devices. In particular, the highly concentrated product flows in battery production are difficult to measure quickly and reliably. One thing is already perfectly clear: the processes throughout battery manufacturing operation need to be optimized in order to achieve target properties and sustain quality.

Towards smart manufacturing in electrode production the implementation of quality gates and establishment of continuous product monitoring is key. Currently the particle size analysis in electrode production is almost exclusively realized through laser diffraction. Due to the high solid content and the presence of different materials in battery slurries, a sample preparation process prior to the measurement is mandatory and therefore in-line measurement requires a lot of effort. A quantitative size measurement of the particles in terms of size, shape or color in real time, directly in the process, can and should make process optimization and control possible. In this regard optical microscopy (1) is a promising alternative that can be used for in-line particle characterization in dry and wet processes.

For this purpose, an in-situ photo-optical analysis method with high spatial and temporal resolution was developed, which has already been tested for reliability in various studies (see Fig. 1). The used measurement technique is capable of acquiring raw data (two-dimensional images) of the dispersed during the process and measure the sizes, shape and colour by means of automated image analysis.



(a) (b) (c)

Fig. 1 – SOPAT system inserted in a battery slurry in an lab environment (a) and industrial production environment (b) and the inline image with analysis results in form of screenshot as well as the full particle size distribution

To evaluate the technology in detail, not only the application in different battery slurries will be shown, but also physical and technological limits of the technology will be discussed in detail. This discussion contains the analysis of the influence of concentration and viscosity of the slurry, set-up of the photo-optical device as well as the influence on the measurement of different slurry materials in general. All results achieved inline will be compared with laser diffraction results to show the comparability of the inline results to existing knowledge.

1. Emmerich J, Tang Q, Wang Y, Neubauer P, Junne S, Maaß S. Optical inline analysis and monitoring of particle size and shape distributions for multiple applications: Scientific and industrial relevance. Chinese Journal of Chemical Engineering. 2019;27(2):257-77.