BattPor: Inline evaluation of Li-ion battery electrode porosity using machine learning algorithms

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The background to current research is the increasing demand for high-performance battery technologies with integrated quality assurance at all stages of production. During the production of lithium-ion battery electrodes, undesirable coating defects and porosity fluctuations can significantly reduce the battery's efficiency and lead to high follow-up costs. These issues are particularly pronounced in the calendering process, which plays a critical role in determining the final electrode quality. The main objective of the BattPor project is to develop automated optical testing technology with AI-based porosity detection in a continuous roll-to-roll calendaring line.

Calendering is a highly error-sensitive step of the cell manufacturing because defects from this step cannot be corrected in the following production and usually only reverse in the formed cell at the end of the process chain. In this process step, a certain porosity is set by post-compacting the coated and dried electrodes. The development of innovative inline measurement method for this approach will create a quality assurance platform for characterization and real-time evaluation of intermediate products during production. It is essential to monitor the porosity in this manufacturing step.

To achieve this, the international consortium contributes to problem solving. In the project BattPor, the electrode sheets developed and manufactured by German Fraunhofer (IKTS-DD) will be measured using the optical inspection method of Laser Speckle Photometry (LSP) developed at other German Fraunhofer (IKTS-MD) and correlated with suitable algorithms for porosity. The Austrian partners (UIBK and PhysTech) reference the local properties of the electrode sheets, as regards both experimental characterization and the porosity, surface roughness, and thermal diffusivity. The pre-qualified LSP laboratory demonstrator will be presented in this work. The in-situ monitoring was performed with the help of AI-based algorithms and the results were calibrated by radiographic method for porosity detection with simultaneous roughness measurement; and in addition, supported by thermal diffusivity simulation.