Simultaneous Multilayer Coating of Lithium-ion Battery Electrodes

Ralf Diehm[1,2], Jana Kumberg[1,2], Philip Scharfer[1,2], and Wilhelm Schabel[1,2]

[1]Institute of Thermal Process Engineering (TVT), Thin Film Technology (TFT), Karlsruhe Institute of Technology (KIT), D-76131 Karlsruhe (Germany)

[2]Material Research Center for Energy Systems (MZE), Karlsruhe Institute of Technology (KIT), D-76131 Karlsruhe (Germany)

ISCST-20180917AM-AB-PL5

Presented at the 19th International Coating Science and Technology Symposium, September 16-19, 2018, Long Beach, CA, USA[†].

Extended Abstract:

Recent developments in the field of lithium-ion battery electrodes are multilayered, graded coatings with different materials and layer properties. This includes different active materials, additive/binder introduced gradients in each layer but also the coating of a primer layer to increase adhesion and electrical conductivity of the battery layer to the metal current collector foil (see figure 1 for layer structure). In this contribution, improvements of electrode properties due to multilayer electrode configuration will be shown (see also [1], [2]).

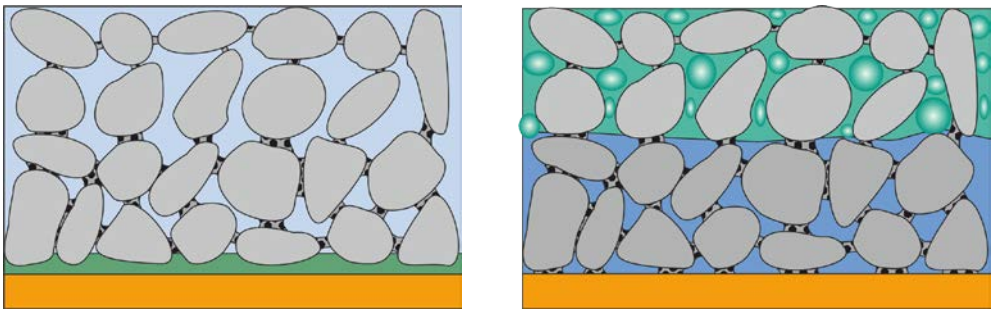

Figure 1: Schematic cross section of lithium-ion battery electrodes. The active material consists of particles which are fixed with a binder and other additives on a metallic current collector foil. The example on the left shows a thin interface layer between active material and substrate foil, which improves the interface mechanically, electrically and chemically. On the right-hand side, a multilayer structure with a predefined binder and pore size gradient is shown.

The advantages of multilayer-coated electrodes will be shown by means of electrode processing and properties as well as battery performance. Simultaneous multilayer coating is a more demanding process compared to single layer coating, due to the interface between both layers (see figure 2) [3], [4]. Different methods of multilayer coating will be discussed with respect to coating window, flow-related layer intermixing and coating quality.

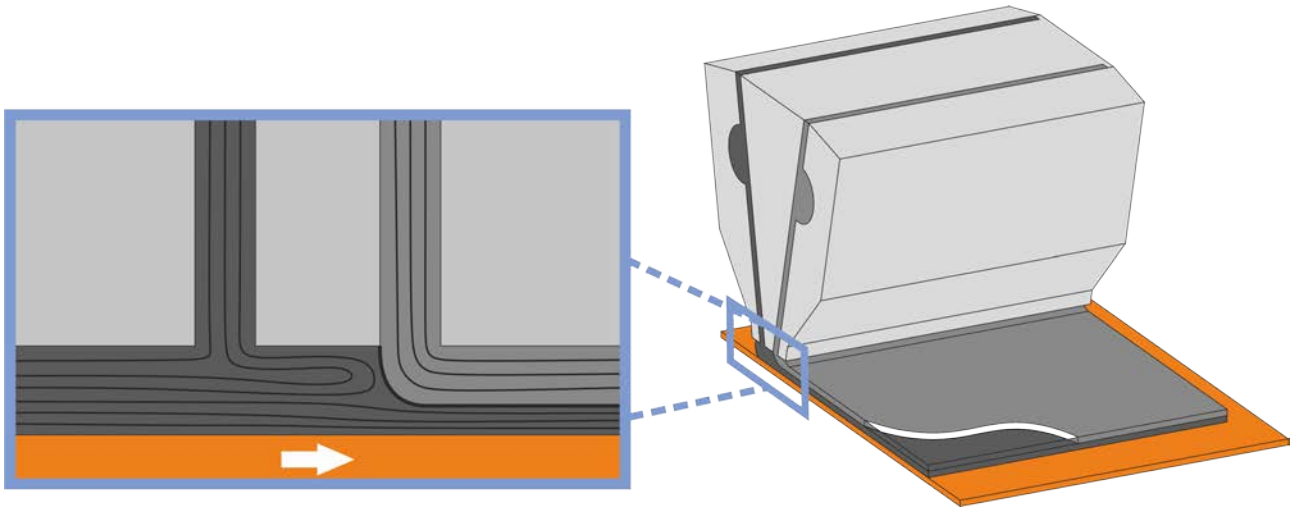

Figure 2: Simultaneous doublelayer slot die with flow profile within the coating gap.

After the coating, the introduced gradient of the multilayer properties is affected by film formation during drying. The influence of different additive concentrations in both layers is discussed with respect to the layer properties, which gives a new path to improve the electrode manufacturing process.

Reference

[1] L. C. Chen *et al.*, “Improvement of lithium-ion battery performance using a two-layered cathode by simultaneous slot-die coating,” *J. Energy Storage*, vol. 5, pp. 156–162, 2016.

[2] D. Liu, L. C. Chen, T. J. Liu, W. B. Chu, and C. Tiu, “Improvement of Lithium-Ion Battery Performance by Two-Layered Slot–Die Coating Operation,” *Energy Technol.*, vol. 5, no. 8, pp. 1235–1241, 2017.

[3] M. Schmitt, S. Raupp, D. Wagner, P. Scharfer, and W. Schabel, “Analytical determination of process windows for bilayer slot die coating,” *J. Coatings Technol. Res.*, vol. 12, no. 5, pp. 877–887, 2015.

[4] J. Nam and M. S. Carvalho, “Mid-gap invasion in two-layer slot coating,” *J. Fluid Mech.*, vol. 631, pp. 397–417, 2009.

Acknowledgements

The authors acknowledge financial support by the Federal Ministry of Education and Research (BMBF) via the ProZell cluster project HighEnergy (contract number 03XP0073B). This work contributes to the research performed at CELEST (Center for Electrochemical Energy Storage Ulm-Karlsruhe)