Drying of battery electrodes – Separation of drying temperature and drying rate induced effects

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During production of anodes for Li-ion batteries, the particulate active material is dispersed in a solvent together with additives and a polymeric binder. This highly viscous slurry is coated on metallic foils and the solvent is removed by drying. Drying temperature [1] and drying rate were identified as relevant influencing parameters for the evolution of the complex internal structure. Drying rate defines the time scale in which rearrangement of components is possible. Drying temperature influences material system parameters like viscosity or diffusion coefficients and therefore changes component mobility in the drying film. A separate investigation of both influencing parameters is complicated by the direct influence of drying temperature on drying rate via the solvent vapor pressure and the phase equilibrium.

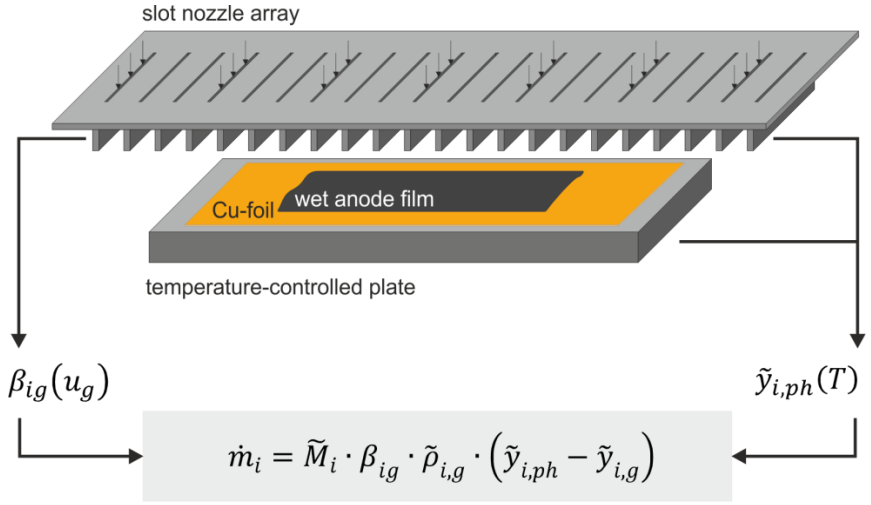

Figure 1: Schematic drawing of the experimental set-up and experimental approach.

The experimental set-up used for this contribution consists of an impingement dryer and a temperature-controlled plate. A homogeneous distribution of drying rates under the slot nozzle array is achieved by a periodical relative movement. The influence of film temperature T on drying rate $\dot{m}$ via the mole fraction at equilibrium $\tilde{y}_{i,ph}$ was compensated by a change in mass transfer coefficients β_{ig} via nozzle outlet velocity u_g (see Figure 1). The settings for a variation of film temperature at a constant drying rate were calculated based on experimentally derived heat and mass transfer coefficients [2]. Calculated conditions were tested by measuring the respective drying kinetic.

The influence of processing conditions was characterized based on film properties. A different influence of drying temperature and rate on film adhesion and electrical resistivity was identified. The findings are explained by a mechanism involving formation of a consolidated layer at the film-air interface during film shrinkage. In this layer a capillary transport of binder relative to the active material is possible. The evolving component gradients are mitigated by diffusion depending on drying conditions.

References

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