Improved Scale-up of Convective Drying Processes by Heat Transfer Rate Measurement

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For functional films (e.g. battery electrodes, adhesive layers, catalytic coatings, optical films and foils) the drying process in a convective dryer is one of the most sensitive steps in the manufacturing process. The transition from wet to solid state determines the evolution of film morphology by elemental processes such as phase separation, migration of components or crystallization. Thus, the resulting film properties strongly depend on the drying conditions. Usually lab and pilot scale drying experiments are used for the development of tailored drying processes. The process is then scaled up to industrial conditions based on a simulation of the drying process.

The material data necessary for the simulation can be taken from material databases or determined in lab experiments. Process temperatures and volume flow rates are typically specified in the machine documentation or easily measured. The most elusive process parameters are the heat and mass transfer coefficients, which depend on drier geometry and volume flow rate. Usually the transfer coefficients are estimated merely with correlations that are often not suitable for the dryer geometry. An alternative is the direct measurement of the heat transfer rate by an appropriate measuring technique.

In this work the basic principle of this technique and the operation of a self-developed sensor is presented. The application of the sensor and the use of the obtained data for scale-up calculations is explained exemplarily.

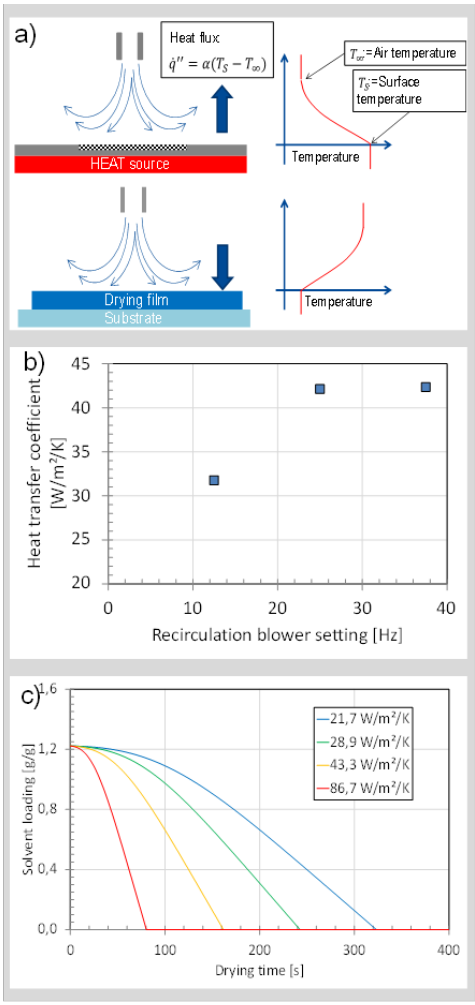

Fig. 1: a: Schematic sketch of the heat flow and temperature profile in an impingement nozzle dryer during measurement with the sensor (top) and film drying (bottom); b: Experimentally determined heat transfer coefficients as a function of blower setting; c) Solvent loading of a film as function of drying time simulated for experimentally determined transfer coefficients.