Stripe Coatings of Low Viscous Fluids

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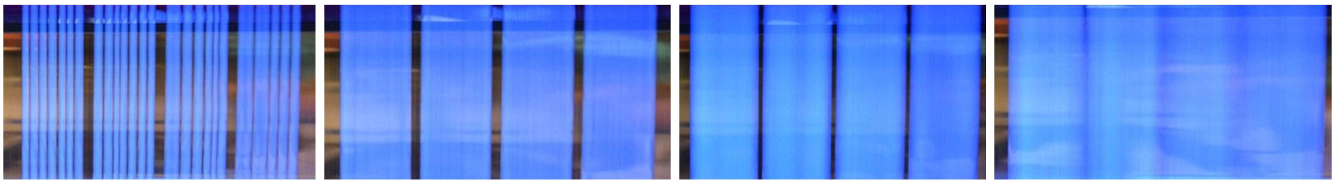
Slot die coating is a technique which is widely used in the field of roll to roll manufacturing of lithium-ion batteries, organic electronics such as organic photovoltaics (OPV), fuel cells and display panels [1, 2]. Recent investigations deal with full area, single- and multilayer coatings whereas only few information about structured slot die coatings can be found. Structured coatings are favorable for producing several devices on the same substrate in one coating step [3].

In this work we investigate different low viscous coating solutions to determine coating windows according to results presented by Carvalho et al. [4] and comparing the results with the correlation for the low flow limit proposed by Wengeler et al. [5] for low viscous solution materials used for OPV applications.

Applying the slot die in eight o'clock position, coatings were performed on a rotating polished steel roll with 350 mm diameter. A continuous coating was realized by removing the wet film at the back side of the steel roll with a knife. Beside the low flow limit another limit was found when underrunning a certain capillary number or exceeding a certain wet film thickness respectively. Investigations were performed for gap widths of 101 µm and 190 µm and different shim geometries. Stripe widths of 20 mm and 24 mm as well as full area coatings were performed. The distance between the single stripes was varied from 5 mm to 1 mm and the distance between upstream and downstream lip was set to 50 µm or 100 µm using different shim thicknesses. After adjusting the substrate velocity, the volume flow of the coating solution was increased starting from coating defects (Figure 1.1) until a stable stripe coating was reached (Figure 1.2). A further increase of volume flow resulted in inhomogeneities (Figure 1.3) until a full area coating was observed (Figure 1.4). Visualization was realized by adding a UV-active component to the coating fluids.



Picture 1.1 till 1.4 showing the change in the appearance of the stripes by increasing the volume flow

Dimensionless coating windows were determined after measuring viscosity and surface tension of the various coating solutions. Results for a critical capillary number (Ca_{crit}) were fitted according to equation 1 presented by Wengeler et al. [5] for the low flow limit:

$$Ca_{crit} = n\left(\frac{2}{G^*-1}\right)^{\frac{3}{2}} \quad (1),$$

with n as numerical, respectively empirical parameter and G* beeing the quotient of gap width and wet film thickness. In addition, a new stability criterium especially for stripe coating was determined at the point when a full area coating was observed.

References

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