Bead behavior in a non-continues slot die coating regime

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Keywords: coating, slot die, sheet-to-sheet, flexible electronics, OLED, barring.

To bring solution processed OLED's, for lighting and signage applications, from laboratory spin-coating towards industrial roll-to-roll production, a scalable intermediate step is desirable. Due to the fact that the electrical current travels perpendicular through the functional layer-stacks of an OLED, the layer thickness has to be very uniform to emit light equally over the whole device area. Sheet-to-sheet slot die coating process should enable high layer uniformity.

Sheet-to-sheet slot die coating processes are very suitable for this purposes. Both coat-ability and OLED efficiencies can be tested on small scale with limited usage of rare and expensive novel materials, before moving to industrial amounts. However, specific needs for this non-continues process have to be taken into account which could limit the degrees of freedom to produce a uniform sheet-to-sheet slot die coated OLED more than subsequently spin-coating or continuous roll-to-roll slot die coating. In a spin-coating process the outwards moving coating front almost instantly dries, which significant increases the process stability by "freezing" the deposited layer.

For sheet-to-sheet slot die coating a precise control of the fluid-bead between the slot die and substrate is essential to minimize leading and especially the trailing edge. When the parameters are outside the coating window, coating defects like streaking and barring will occur. Furthermore it is also possible that coating material is accumulating at the lips of the slot die which will result in a non-uniform increasing layer thickness and a massive trialing edge.

In this research slot die coating bead behavior in a non-continues regime is observed and strategies are developed to prevent coating defects and minimalize leading and trialing edge.

The slot die bead was closely studied in real-time in a non-continues coating with non-linear velocity regime.

Observations clearly show correlations between:

- A low coating velocity result in material accumulation at the slot die, this result in a not-uniform coating layer with an increased layer thickness in the coating direction and an increased trailing edge when the slot die is lifted, as shown in Fig. 1.

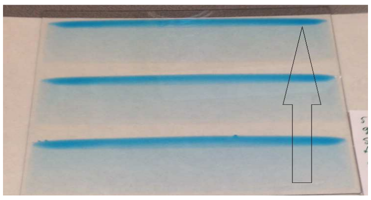

Fig. 1: Layer with large trailing edge and non-uniform coating.

- At relative high coating velocity and thin layer the coating-bead might become unstable and start to flutter at the slot die lips. This will result in the barring of the coating film, as is shown in Fig. 2.

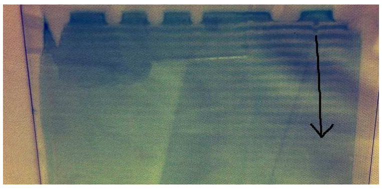

Fig. 2: Unstable coating resulting in barring.

- At the start of the coating a fine balance between coating bead volume and acceleration has to be considered to prevent the rise of a single "coating bar" at the point of –velocity-accumulation-threshold- as shown in Fig. 3.

Picture will follow
Fig.3: Layer with large leading edge and non-uniform coating.

The results can be used to predict the succesrate for a uniform defect free coating with a certain coating material at a certain wet layer thickness, when an optimum coating gap, velocity and acceleration is used.