Experimental and computational analysis of tensioned-web-over-slot die coating

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Tensioned-web-over-slot die (TWOSD) coating is one of the most successful high-speed liquid coating process. It deploys elastohydrodynamic interaction to control the distance between the moving substrate and the coating die lip surface in order to be able to coat an ultra-thin liquid layer. However, flow insta- bilities that come from the gas-liquid interface and micro vortices inside the flow may lead to coating defects. Therefore, the range of operating conditions of uniform coating is limited. Nam and Carvalho (2010) proposed a two-dimensional computational model to examine the role of the elastohydrodynamic interaction between the liquid and flexible substrate in tensioned-web-over-slot die (TWOSD) coating process, with the goal of predicting the operability limits of the process. Here, we use flow visualization on a laboratory-scale TWOSD coating apparatus to study limit flow states which are related to various flow instabilities and appearance of vortex in the flow. The visualizations show the progression of flow states beyond critical flow parameters which cannot be predicted by the model. Furthermore, the critical flow rates, that define the operability window of the process, were determined experimentally and were used to validate the computational model.