Elastohydrodynamics of Gravure: Lubrication Flow between a Cavity and a Flexible Wall

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Gravure coating and printing are processes for generating micron-scale films and patterns in a continuous manner. As a first step in uncovering the mechanisms of liquid transfer from gravure cells and grooves to the web (direct gravure) or the backing roll (offset gravure), the flow between a rigid cavity and a flexible wall is studied with a lubrication model. In this model, it is assumed that the liquid flow between the cavity and the flexible wall is governed by Reynolds equation, and that the flexible wall is backed by a series of springs (offset gravure) and/or held by a uniform tension force (direct gravure). When the wall modulus or tension is large relative to the viscous forces, the wall hardly deforms and both a pressure mountain and valley are observed due to the gap change produced by the cavity topography. When the wall modulus and tension are small relative to the viscous forces, the wall easily deforms and assumes a shape similar to that of the cavity. The pressure profiles are also dramatically altered and in some cases show only a valley without a mountain. In addition to benefiting gravure operations, these results complement studies of driven-cavity flow.