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Thin-Liquid-Film Flow on Three-Dimensional Topographically Patterned Rotating Cylinders CHANCE PARRISH, LUCAS PHAM, SATISH KUMAR, Department of Chemical Engineering and Materials Science, University of Minnesota — The coating of rotating discrete objects with surface topography is a problem commonly encountered in manufacturing processes. To study this problem, we model the flow of thin liquid coatings in three dimensions on topographically patterned cylinders that rotate about their horizontal axes. An evolution equation describing variations in the coating thickness is solved numerically. In the limit of a rapidly rotating cylinder, we find that liquid accumulates at either pattern crests or pattern troughs. Using a long-wave analysis, we derive an expression for the critical Weber number separating these regimes. When gravity is reincorporated, the accumulation of liquid at crests or troughs may cause the coating to sag, leading to the formation of droplets or rings whose average spacing at large rotation rates is controlled by the balance between centrifugal and surface-tension forces. Flow visualization experiments yield results that agree quantitatively with predictions of the simulations and long-wave analysis. We observe the most uniform coatings in experiments at moderate rotation rates, where disturbances in the coating thickness develop slowly. This indicates that to obtain nearly uniform coatings in practice, the coating must be solidified faster than disturbances can develop.

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