Thin-film flow of a Bingham fluid over topography with a temperature dependent rheology

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ABSTRACT

We consider the flow of a viscoplastic fluid on a horizontal or an inclined surface with a flat and an asymmetric topography. A particular application of interest is the spread of a fixed mass – a block – of material under its own weight. The rheology of the fluid is described by the Bingham model which includes the effect of yield stress, i.e. a threshold stress which must be exceeded before flow can occur. Both the plastic viscosity and the yield stress are modelled with temperature-dependent parameters. The flow is described by the lubrication approximation, and the heat transfer by a depth-averaged energy conservation equation. Results show that for large values of the yield stress, only the outer fraction of the fluid spreads outward, the inner fraction remaining unyielded. We also present an analysis which predicts the threshold value of the yield stress for which partial slump occurs.