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MODELLING OF STRAIN LOCALIZATION OF A LIQUID-CORE CAPSULE IN FLOW †

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Capsules composed of a droplet surrounded by a thin elastic membrane offer promising biomedical applications for the controlled release of an active substance. But one limitation comes from the lack of model of the damage/rupture of capsules when they are in flow. Recently, we developed a fluid-structure interaction numerical model of the damage of a capsule in Stokes flow [1], which couples the finite element method, to solve for the membrane deformation, with the boundary integral method, to solve for the fluid flows. The objective of the present work is to extend this model to take into account the subsequent phenomenon of strain localization corresponding to the concentration of strain in zones of very small thickness over the membrane. These zones of localization are precursors of the onset of a crack. Following the strong discontinuity approach [2], we consider that the localized dissipative mechanisms in the zones of localization correspond to a surface dissipation described by discontinuous displacement fields and a brittle cohesive law relating the traction and the displacement jump. We study the strain localization for a spherical capsule in simple shear flow. When the capillary number, ratio of the fluid viscous forces to the membrane elastic forces, is larger than a threshold value, strain localization initiates at the two points on the vorticity axis, and propagates rather perpendicularly to the direction of elongation of the capsule. The lower the fracture energy introduced in the cohesive law, the faster the localization zones propagate. When the local dissipated energy reaches the fracture energy, a crack initiates at the two points on the vorticity axis and we can estimate that they will propagate following the path of the localization zones. This work presents the first model describing the damage mechanisms and the mode of rupture of a capsule in flow until the onset of cracks.

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