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FINITE ELEMENT MODELING OF VISCOUS EFFECTS ON INEXTENSIBLE MEMBRANES

Roberto F. Ausas*, Fernando Mut and Gustavo C. Buscaglia

*Instituto de Ciências Matemáticas e de Computação,
Universidade de São Paulo, São Carlos, SP, Brazil

Resumo

Phospholipidic membranes rheologically behave as two dimensional fluids in which surface viscous effects are relevant as compared to those on the bulk fluids where they are immersed. These effects are also important in capillary interfaces in the presence of surfactant agents and/or impurities. In the case of lipidic membranes, they are also subjected to local area or inextensibility constraints. In this work we use the Boussinesq-Scriven operator, which is the surface analog of the Newtonian constitutive behavior, as a way to model both, surface viscous effects and inextensibility on interfaces. The standard way to impose the area constraint is by means of a surface membranal pressure, i.e., a Lagrange multiplier associated to the inextensibility restriction. Instead, in this work we increase the value of the second viscosity coefficient in the Boussinesq-Scriven law. While this would lead to the numerical phenomenon of locking in similar problems, we show by means of several numerical experiments that this does not happen so easily in our case. This allows us to impose, at least to some extent, the surface incompressibility, with two advantages: first, one less unknown per node is required and second, a better conditioning of the algebraic linear systems can be expected. Additionally, this approach would greatly facilitate the implementation of the area restriction in level set formulations where no explicit representation of the interface is available to define a local Lagrange multiplier.