Interfacial instabilities driven by chemical reactions

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Abstract

We consider the interaction between a horizontal thin liquid film and a reaction-diffusion process on the surface of the film. The reaction-diffusion process is modeled by the bistable/excitable FitzHugh-Nagumo prototype, a system of two equations for the evolution in time and space of two species, the activator and inhibitor. It is assumed that one of the species, the inhibitor, acts as a surfactant and the coupling between hydrodynamics and chemistry occurs through the solutocapillary Marangoni effect induced by spatial changes of the inhibitor's concentration. The coupled system is analyzed with a long-wave expansion of the hydrodynamic equations of motion, transport equations for the two species and wall/free-surface boundary conditions. Depending on the values of the pertinent parameters, the bistable/excitable medium can induce both periodic stationary patterns and solitary waves on the free surface.