A novel linear second order unconditionally energy stable scheme for a hydrodynamic Q-tensor model of liquid crystals

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COMPUTER METHODS IN APPLIED MECHANICS AND ENGINEERING
Volume: 318 Pages: 803-825
DOI: 10.1016/j.cma.2017.01.031
Published: MAY 1 2017

Abstract
The hydrodynamic Q-tensor model has been used for studying flows of liquid crystals and liquid crystal polymers. It can be derived from a variational approach together with the generalized Onsager principle, in which the total energy decreases in time. In this paper, we develop a novel, linear, second order semi-discrete scheme in time to solve the governing system of equations in the model. The scheme is developed following the novel 'energy quadratization' strategy so that it is linear and unconditionally energy stable at the semi-discrete level. This scheme is further discretized in space using a second order finite difference method and implemented on a GPU for high performance computing. The convergence rate in time is established using a mesh refinement test. Several numerical examples are presented to demonstrate the usefulness of the model and the effectiveness of the numerical scheme in simulating defect dynamics in flows of liquid crystals. (C) 2017 Elsevier B.V. All rights reserved.

Keywords
Author Keywords: Q-tensor model; Energy quadratization; Hydrodynamics; Unconditional energy stability; Linear; Second order
KeyWords Plus: PHASE-FIELD MODEL; THIN-FILM EPITAXY; NAVIER-STOKES; IRREVERSIBLE-PROCESSES; INCOMPRESSIBLE FLOWS; RECIPROCAL RELATIONS; EQUATIONS; APPROXIMATIONS; STABILITY; POLYMERS

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