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Phase diagram of vorticity response to surface waviness in viscoelastic Couette flow JACOB PAGE, Imperial College London, TAMER ZAKI, Johns Hopkins University — The response of viscoelastic Couette flow to surface waviness on the lower wall is examined for both Oldroyd-B and FENE-P fluids. The elasticity of the fluid supports vorticity wave propagation along the tensioned streamlines, which results in the formation of a critical layer where the elastic wave speed matches the base velocity. The induced vorticity is quantified using an integral measure of its penetration into the bulk flow. The flow response to the roughness is classified using a phase diagram, analogous to the Newtonian problem (Charru & Hinch, J. Fluid Mech. 2000). The main parameters in the viscoelastic configuration are the ratios of the channel depth and the critical layer height to the surface wavelength. In deep channels, a significant vorticity is generated away from the wall at the critical layer through a kinematic amplification mechanism. For shallow channels the flow response is dictated by elastic effects, and vorticity amplification occurs in a thin boundary layer at the upper wall. Fourier superposition is used to extend the results to localized wall bumps. Unlike the Newtonian fluid where a single vortex forms above the bump, in the viscoelastic flow an additional upstream vortex of opposite sign is induced by the large vorticity at the upper wall.

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