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Viscoelastic instabilities generate filamentous flows and enhance dispersion in porous media JEFFREY S. GUASTO, DEREK WALKAMA, NICOLAS WAISBORD, Tufts University — Viscoelastic porous media flows are ubiquitous in both nature and industry, where their unique transport properties can dominate the function and performance of relevant systems. Utilizing a microfluidic model porous medium, we map the flow topology of a viscoelastic fluid (400ppm PAA in 87% aqueous glycerol) via micro-PIV for a range of Weissenberg numbers (Wi) and pore geometries. We demonstrate that steady filamentous flow patterns are present in viscoelastic flows at moderate Wi, which dominate longitudinal transport and increase dispersion relative to Newtonian flows. As Wi increases in flow through disordered porous media, existing high velocity filaments grow, while flow through low velocity regions is further suppressed. We directly demonstrate that the resulting increase in the spatial correlation length of the flow topology is linked to the dispersive properties of the flow field, in line with recent theory. With precise control over the geometrical order/disorder of the porous medium through lithography, we also demonstrate that in the limiting case of a ordered, hexagonal microstructure, the flow topology undergoes a bifurcation at a critical Wi representative of mirror symmetry breaking.

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