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Formation of beads-on-a-string structures during the pinch-off of viscoelastic filaments PRADEEP BHAT, SANTOSH APPATHURAI, MICHAEL HARRIS, Purdue University, West Lafayette, IN 47907, MATTEO PASQUALI, Rice University, Houston, TX 77005, GARETH MCKINLEY, Massachusetts Institute of Technology, Cambridge, MA 02139, OSMAN BASARAN, Purdue University, West Lafayette, IN 47907 — Breakup of liquid filaments is omnipresent in nature and technology. When a filament formed by placing a drop of syrup between a thumb and a forefinger is stretched by pulling apart the two fingers, it resembles a thinning cylinder. If the same experiment is repeated with saliva, the filament's morphology close to pinch-off resembles that of beads of several sizes interconnected by slender threads. Although there is general agreement that formation of such beads-on-a-string (BOAS) morphology only occurs for viscoelastic fluids, the mechanism behind this phenomenon remains unclear and controversial. The physics of formation of BOAS structures is probed here by simulation which reveals that viscoelasticity alone does not give rise to a small, satellite bead between two much larger main drops (beads) but that inertia is required for its formation. Viscoelasticity, however, enhances the growth of the satellite bead and delays pinch-off, which leads to a relatively long-lived, stable beaded filament. The new simulations also show the formation of second-generation sub-satellite beads in certain cases, as observed experimentally but not, heretofore, predicted theoretically.

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