Capillary breakup of free and wetting Xanthan Gum liquid bridges
–Supplemental Material–

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The Supplemental Material consists of two sections. Section S1 examines the influence of the liquid injection rate on the breakup dynamics of a representative free xanthan gum liquid bridge. Section S2 presents the extensional rate as a function of the minimum bridge diameter for the same selected free XG liquid bridge.

S1 Influence of the liquid injection rate on breakup dynamics

To assess the possible influence of the liquid injection rate on the breakup dynamics, experiments were performed using two injection rates of 2 and 20 µl/min. Previous studies have shown that the breakup dynamics of Newtonian free liquid bridges is only marginally affected by the injection rate, even for rates two orders of magnitude higher than those considered here (Castrejón-Pita et al. 2012). In contrast, polymer solutions may, in principle, exhibit flow-history-dependent behavior, such that pre-stretching during bridge formation could influence the subsequent breakup dynamics (Hu et al. 2025). Nevertheless, as shown in Fig. S1, the evolution of both the minimum bridge width and the breakup velocity is virtually identical for the two injection rates, indicating that the influence of the injection rate is negligible over the investigated range.

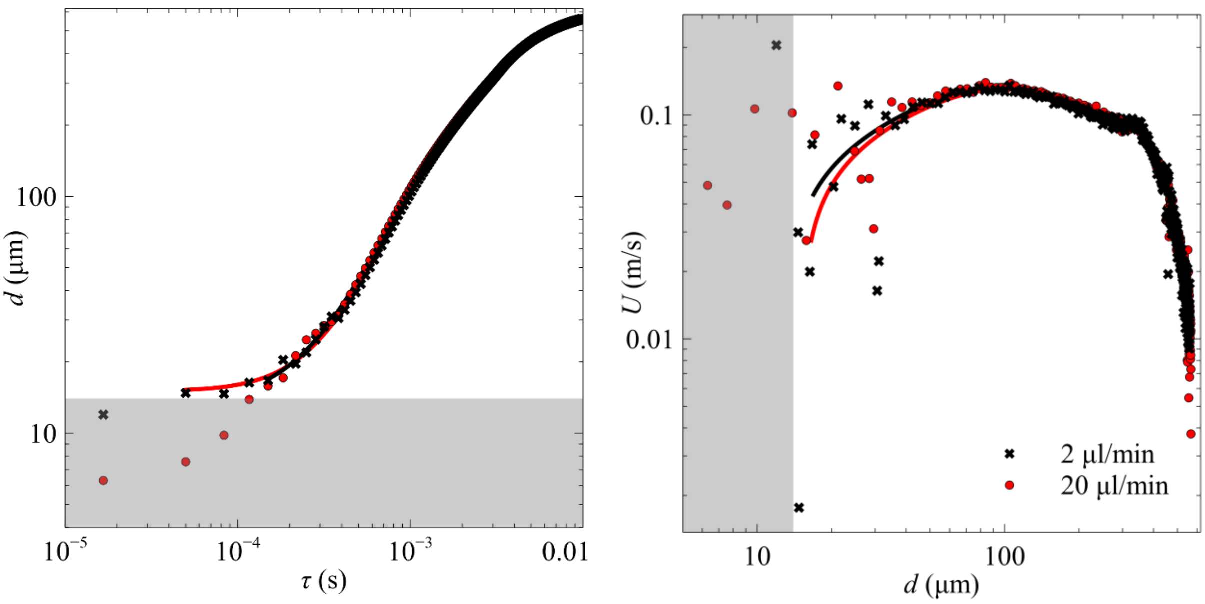

Figure S1: Influence of the liquid injection rate on the breakup dynamics of free 200 ppm xanthan gum-in-water bridges. (a) Minimum diameter against time before breakup, (b) breakup velocity against minimum diameter. Due to loss of resolution of the imaging system, less emphasis should be put on the shaded areas.

S2 Identification of the onset of the elasto-capillary regime

Since the minimum bridge diameter, d, decreases monotonically with the time before breakup, τ, the $U - d$ and $\dot{\epsilon} - d$ representations contain equivalent information regarding the evolution of the breakup dynamics. Consequently, a kink in the $U - d$ curve necessarily corresponds to a kink in the $\dot{\epsilon} - d$ (and equivalently $\dot{\epsilon} - \tau$) curve, as demonstrated in Fig. S2. Dinic *et al.* identified this kink in the extensional rate representation as the onset of the short-lived elasto-capillary (EC) response (Dinic et al. 2020). Accordingly, we identify the corresponding kink in the $U - d$ representation as the onset of the EC regime throughout this work.

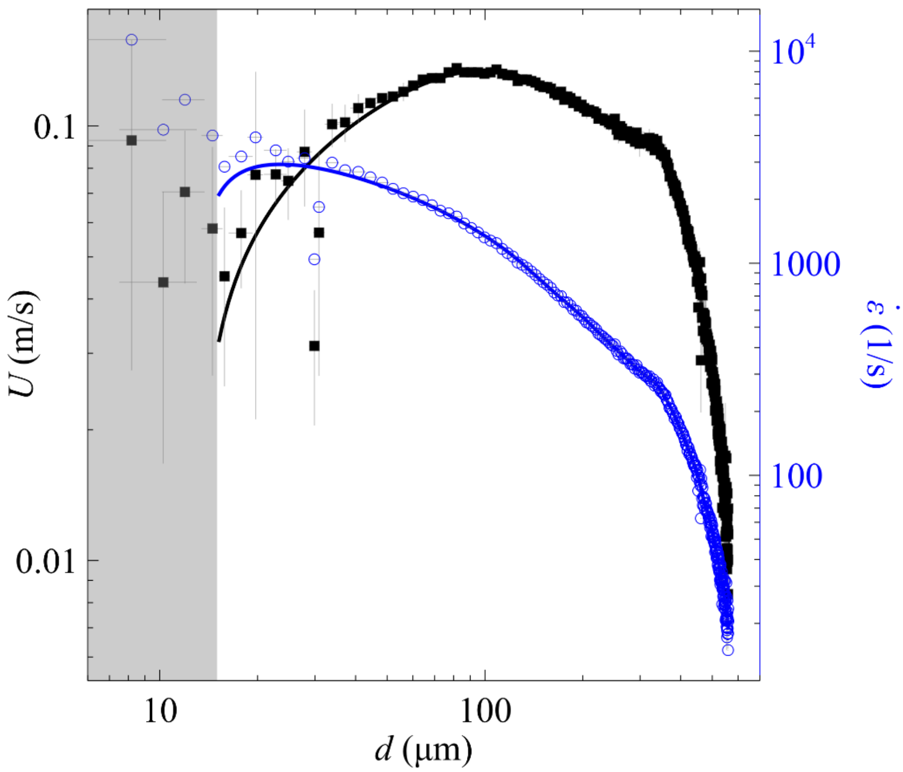

Figure S2: Breakup velocity and strain rate, respectively on the left and right axis, against minimum diameter for a free liquid bridge with 200 ppm xanthan gum in water. The kinks in both curves occur at the same bridge diameter, demonstrating that the two representations provide an equivalent identification of the dynamic transition. Due to loss of resolution of the imaging system, less emphasis should be put on the shaded area.

References

Castrejón-Pita JR, Castrejón-Pita AA, Thete SS, et al (2015) Plethora of transitions during breakup of liquid filaments. Proc Natl Acad Sci USA 112:4582–4587

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