Supporting Information
History-dependent depolymerization of actin filaments

Ishutesh Jain[1], David Lacoste[2], Dulal Panda[1] Ranjith Padinhateeri[1]
1 Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay, Powai, Mumbai 400076, India.
2 Laboratoire de Physico-Chimie Théorique, CNRS UMR Gulliver, ESPCI, 10 rue Vauquelin, Paris Cedex 05, France

Comparison with experiments

Comparison with Jegou et al Ref. [1]

The comparison of our simulations with data in Ref [1] is shown in Fig. S1. We have achieved a good fit of the data of Jegou et al. using our model in the constant concentration setup appropriate for that experiment. This fit includes two parameters W_T and W_D which play a similar role as the parameters introduced by Jegou et al. in Ref [1], which are called $v_{depol}^{ADP-P_i}$ and v_{depol}^{ADP}. As expected, the values obtained for these parameters ($W_T \approx 1.5$ and $W_D \approx 7$) are rather close to the values obtained by Jegou et al. Therefore, our data will fit well with the Jegou et al without making any specific assumption about fast phosphate release at the barbed end.

Jegou et al has argued that $v_{depol}^{ADP-P_i}$ is an "effective depolymerization velocity". Since our model is also a two-state model, similar to Jegou et al, we could also assume that the W_T is an effective rate. If we consider W_T as an effective rate, we may not be able to either confirm or reject the idea of fast phosphate release.

However, if the barbed end of the filament is dominated by ATP-bound actin, one can consider W_T as the off-rate ATP-bound actin; then there is no fast phosphate release at the barbed end. We think that by performing a mass conservation experiment, one might be able to test whether the filament is dominated by ATP-bound or ADP-Pi-bound actin. In the mass-conservation experiment, to obtain the kinds of results we predicted, we need to have U_T. If there is no ATP-bound actin, as assumed in the Jegou et al paper, then one would expect a different kind of dynamics in the mass-conservation set up.

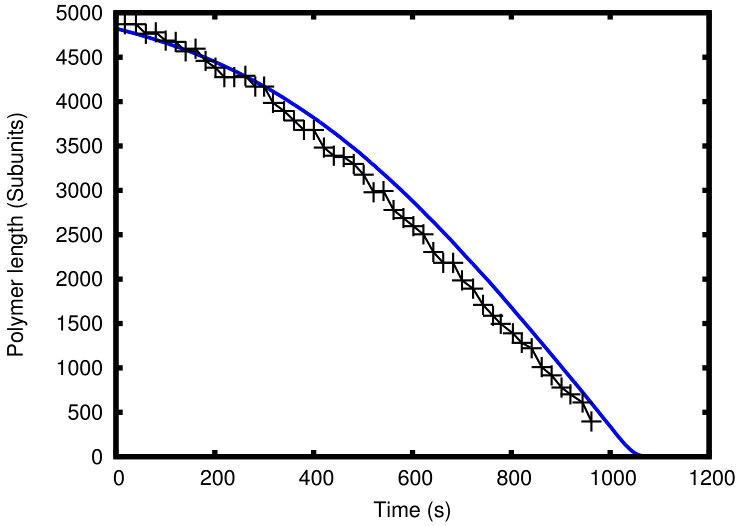

Fig. S 1. Comparison with Jegou et al: Black curve is adapted from figure 2b of Jegou et al [1] which shows depolymeization of an actin filament under a set-up similar to our constant concentration set-up . Blue curve shows the result obtained from our simulation. In this simulation, filaments are polymerized for 10 min (i.e. $t_p = 10$min) and then depolymerized under constant concentration condition where $C_T = 0$ and $R_r = 0.003$.

Comparison with Kueh et al Ref. [2]

In Fig. 2, we have compared our theoretical Eq. 7 with the data in Fig 1E in Ref. [2].

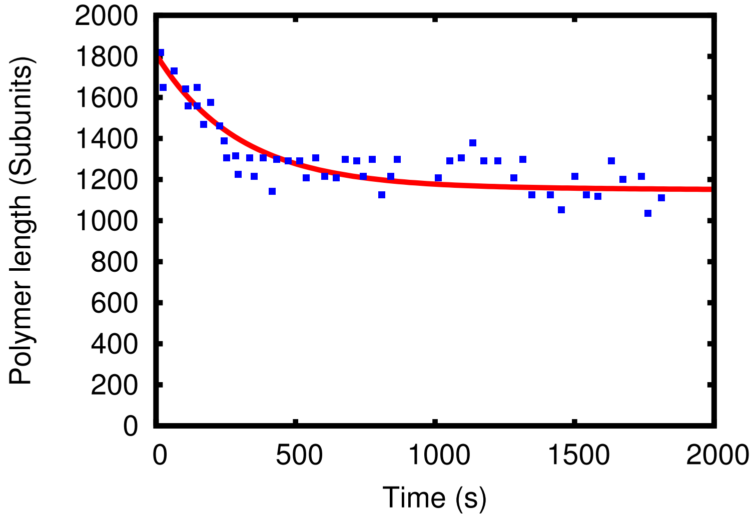

Fig. S 2. Experimental data (blue dots) from Kueh et al (see Fig 1E in Ref. [2]) is compared with our theoretical formula shown in Eq. 7 of the paper (red curve). The parameters used are $P_T^+ = 1.0$, $P_T^- = -0.00002t + 1.0$, $l_o = 1810$ subunits, $C_o = 0\mu$ M and $C_f = 0.00026\mu$M.

Supporting data

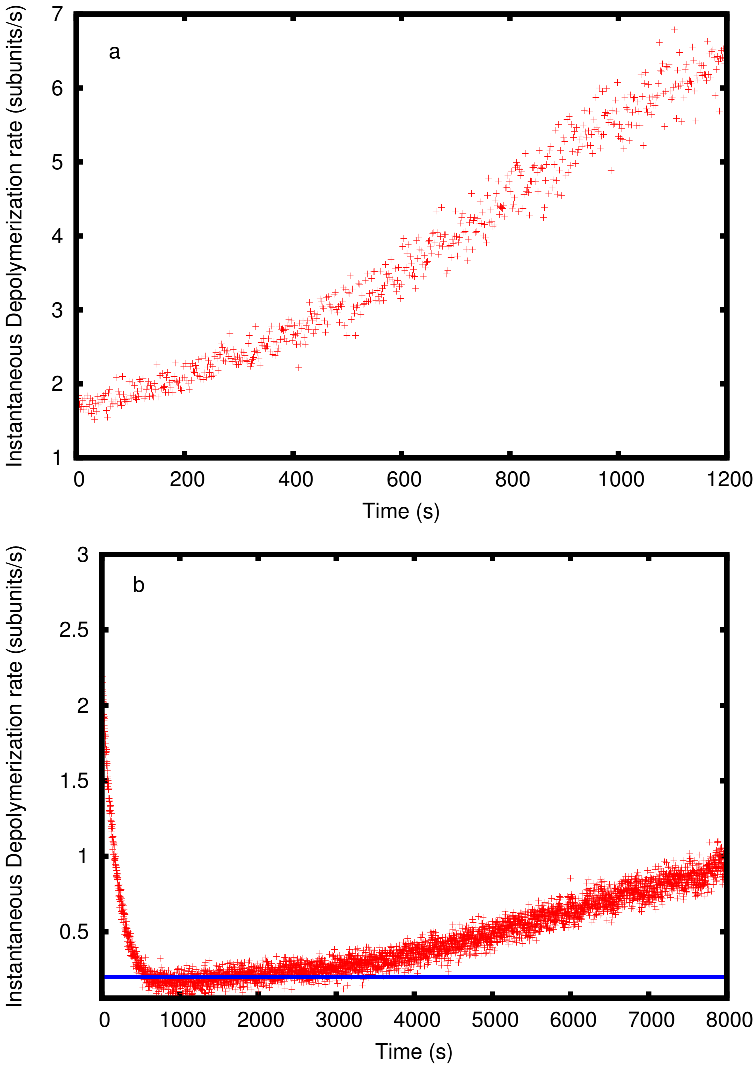

Fig. S 3. Instantaneous depolymerization velocity of depolymerizing filaments. Fig (a) is complimentary to Fig 3 in the manuscript. As we can see, at early times, the velocity is very small, and at later times the velocity is very large; in other words, the system has gone from a low-velocity regime to a high-velocity regime in a continuous manner. Fig (b) is complimentary to Fig 4 in the manuscript, showing the three regime case, where at early times, the velocity is high, after some time, the velocity becomes very small, and towards the end of the simulation the velocity again becomes large. The blue line is marking 0.2 subunits/s.

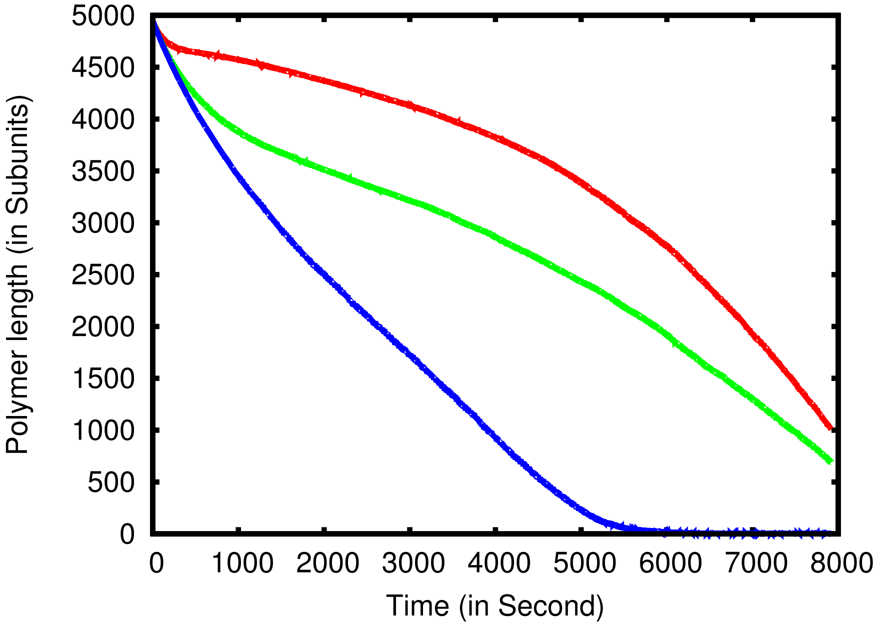

Fig. S 4. Depolymerization dynamics at different filament concentrations (C_f) under mass conservation setup. In all these simulations $R_r = 10^{-3}s^{-1}$. Red curve is for $C_f \approx 0.55$nM, green curve for $C_f \approx 0.15$nM and blue curve is for $C_f \approx 0.09$nM.

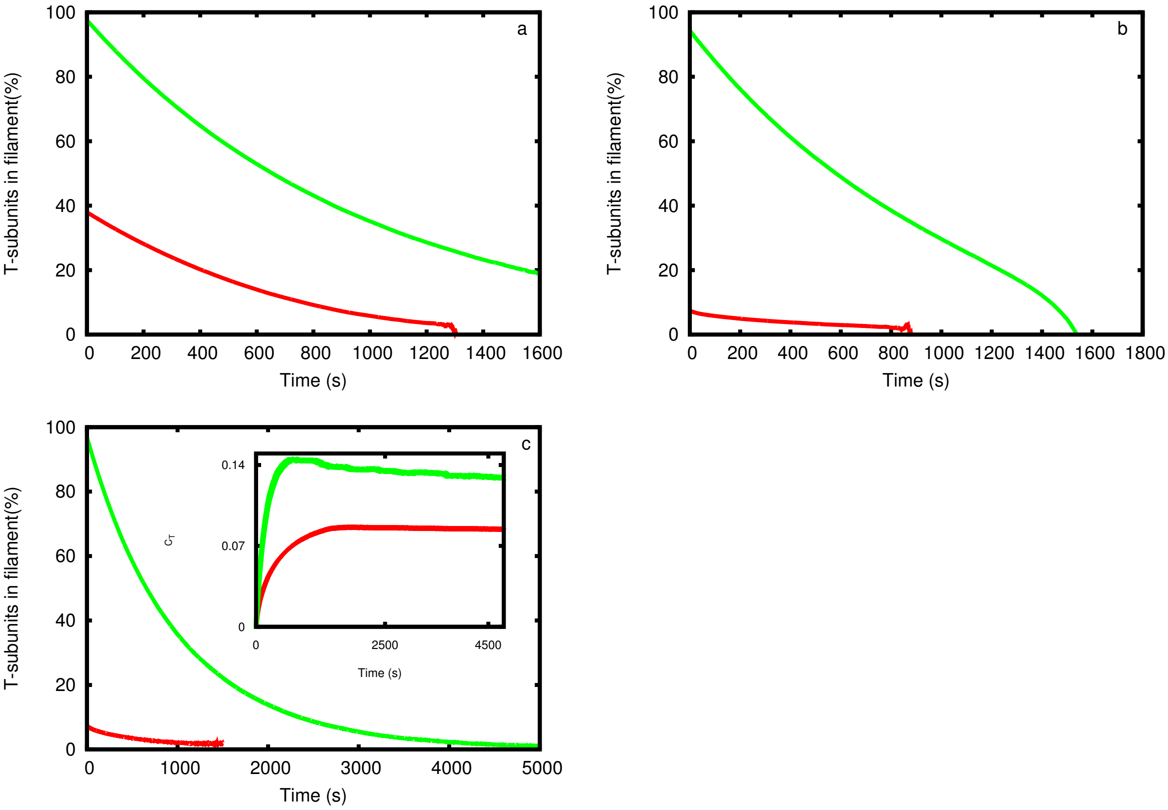

Fig. S 5. Dynamics of T-bound subunits and history of polymerization: This figure is complementary to fig 6 of the manuscript. Here we have plotted the fraction of T-bound subunits in the filament as a function of time. Green curves, throughout this figure, correspond to filaments which polymerized for short time ($t_p \approx 1$min $\ll 1/R_r$) and red curves correspond to filaments which polymerized for long time ($t_p \approx 50$min $\gg 1/R_r$).(a) Polymerization and depolymerization under constant concentration condition.(b) Polymerization under mass-conservation condition and depolymerization under constant concentration condition.(c) Both polymerization and depolymerization are under mass-conservation condition. The inset is showing the dynamics of free T-bound subunit concentration C_T.

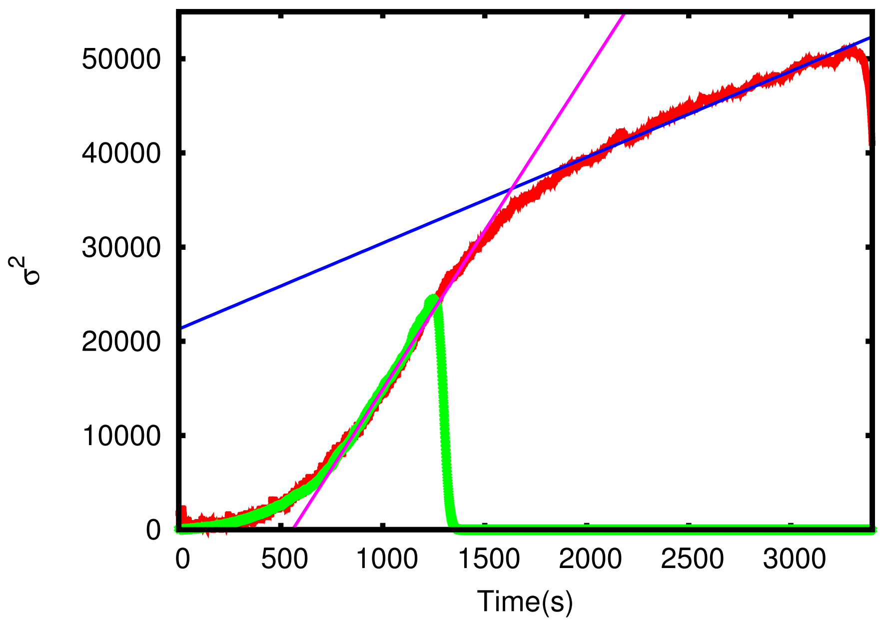

Fig. S 6. Finite length effect on diffusion coefficient during depolymerization. Here both the curves are polymerized and depolymerized under identical condition. i.e. first, the filaments are polymerized at constant concentration for long time ($t_p \approx 50$min $\gg 1/R_r$), and then depolymerized at constant concentration of $0.005\mu M$. The only difference is the filament length. Green curve stands for filament of length 5000 subunits and red curve stands for filament of length 20000 subunits. During depolymerization the variance is calculated and plotted here. Blue line has a slope of $9.1 subunit^2 sec^{-1}$ and purple has a slope of $33.7 subunit^2 sec^{-1}$.

References

1. Antoine Jégou, Thomas Niedermayer, József Orbán, Dominique Didry, Reinhard Lipowsky, Marie-France Carlier and Guillaume Romet-Lemonne. *Individual Actin Filaments in a Microfluidic Flow Reveal the Mechanism of ATP Hydrolysis and Give Insight Into the Properties of Profilin.* PLoS Biology **9** (9), e1001161 (September 2011).

2. Hao Yuan Kueh, William M Brieher and Timothy J Mitchison. *Dynamic stabilization of actin filaments.* Proceedings of the National Academy of Sciences of the United States of America **105** (43), 16531–6 (October 2008).