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Supplemental Information

Tuning Cell Motility via Cell Tension with a Mechanochemical Cell Migration Model

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Supporting Materials

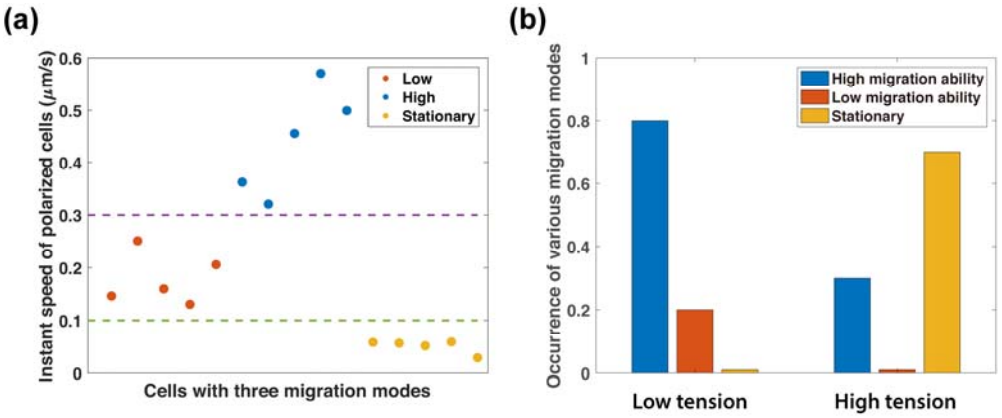

FIGURE S1 Statistics on migration modes.

(a) Cell migration is classified into three distinguishable modes: high migration (blue dots), low migration (scarlet dots), and stationary (light brown dots) according to the mean values of instant speed of each simulation. The threshold values of $0.3\,\mu m/s$ between low and high migrating modes (dashed line in purple) and $0.1\,\mu m/s$ between low and stationary modes (dashed line in green) are determined via *k*-mean clustering..

(b) When cell tension is low, high migration ability mode is dominant (~80%) and cells are mobile as they are seldom in stationary state (left panel). However, when cell tension is high, most of cells are in stationary state (~70%) with the rest of them in a random movement (right panel).

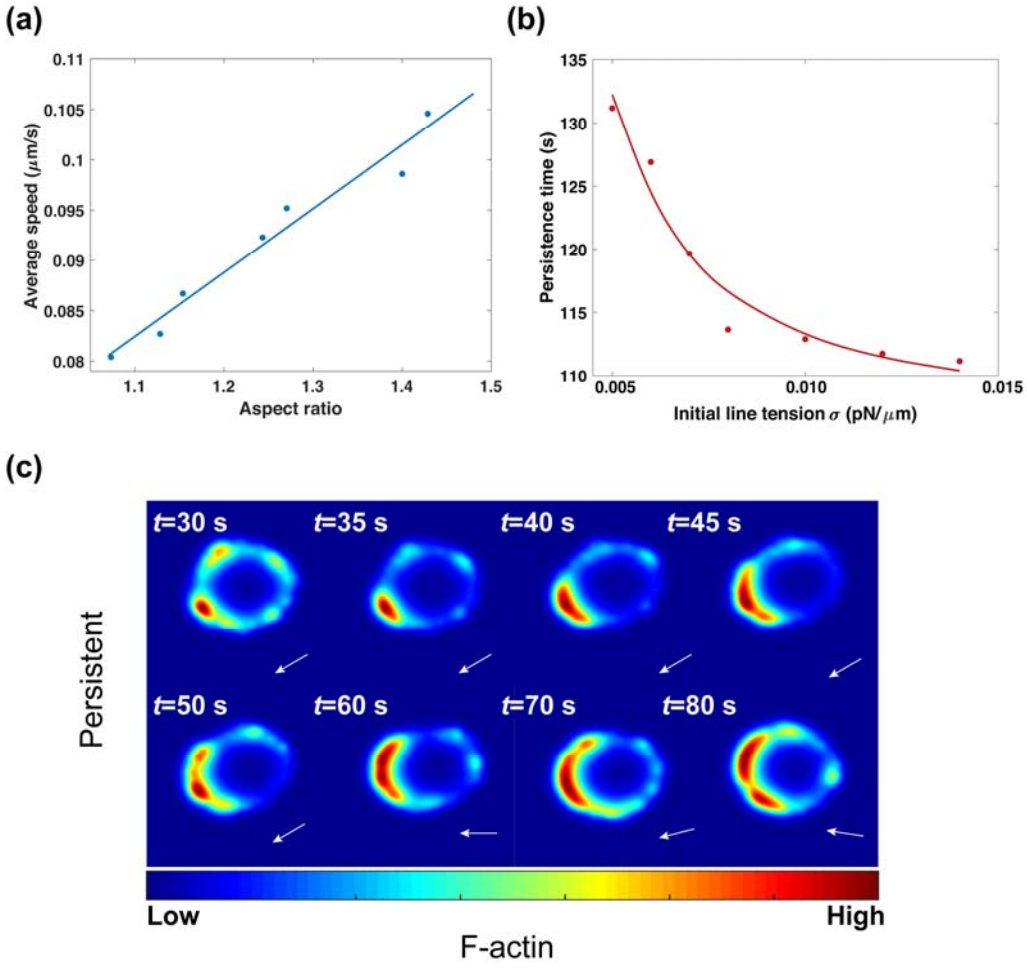

FIGURE S2 Persistent migration with presence of external stimuli.

(a) Relation between aspect ratio and average speed. Dots are samples from simulation with blue solid line fitting to them via linear regression (Goodness of fit $R^2 = 0.9542$).

(b) Relation between initial line tension and persistent time. Dots are samples from simulation with scarlet solid line fitting to them via power law regression (Goodness of fit $R^2 = 0.9316$).

(c) Persistent migration mode under coexistence of external stimuli and random internal noise. Color-bar indicates the concentration of F-actin and white arrows mean the migrating directions.

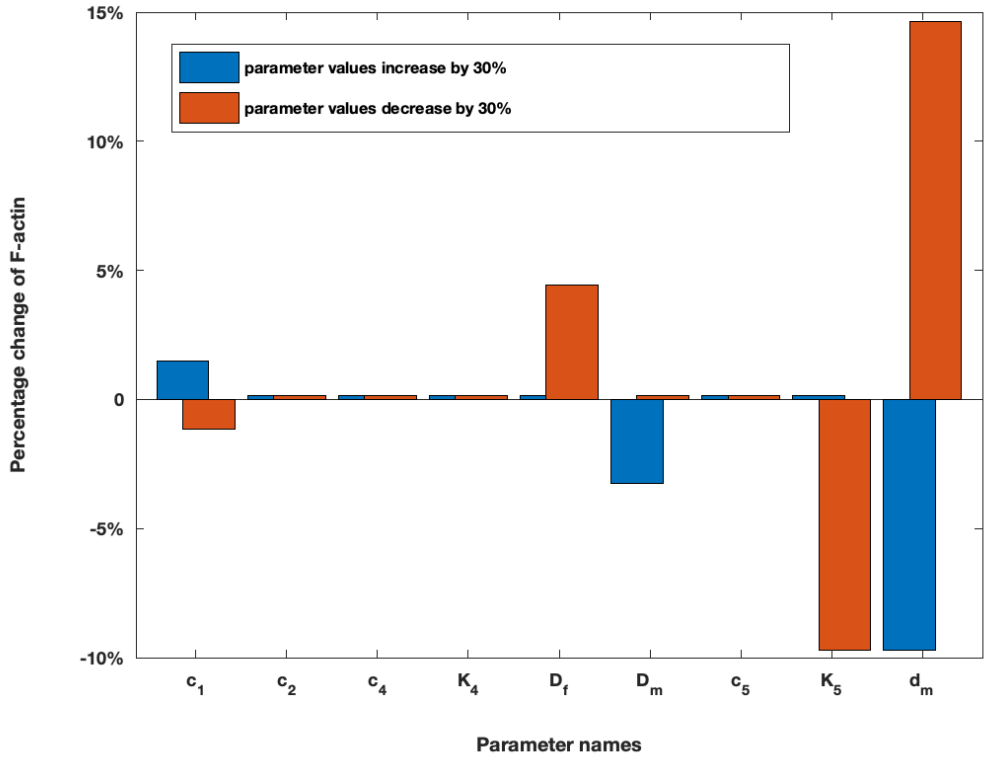

FIGURE S3 Parameter sensitivity analysis for estimated parameters.

S1-S2 Movies Simulations of morphological patterns when the initial line tension is attuned as $0.005\,pN/\mu m$ and $0.015\,pN/\mu m$ respectively.

S3-S5 Movies Movements of spontaneous polarized MDA-MB-231 cells without any external gradient stimuli.

S6-S7 Movies Simulations of persistent migration mode under external stimuli when initial line tension is attuned as $0.005\,pN/\mu m$ and $0.015\,pN/\mu m$ respectively.

Table S1 Values of Parameters in the mechanochemical cell migration model.

Parameter	Figure 1 (b)-(d), Figure 3 (a)-(c), Figure 5 (b)	Figure 2 (a) and (c), Figure 4 (a)-(d), Figure 5 (a)	Unit	*Reference*
D_u	0.1	0.1	$\mu m^2 s^{-1}$	*(55)*
D_v	50	50	$\mu m^2 s^{-1}$	*(55)*
b	0.001	0.001	s^{-1}	*(3)*
c_1	1	1	s^{-1}	--
K_1	6	6	μm^{-2}	*(3)*
c_2	0.2	0.2	s^{-1}	--
K_2	3	3	μm^{-1}	*(3)*
r	1	1	s^{-1}	*(56)*
c_3	6	6	$\mu m^{-2} s^{-1}$	*(3)*
K_3	3	3	μm^{-2}	*(3)*
K_F	1	1	$pN\mu m^{-1}$	--
c_4	1	1	$\mu m^{-2} s^{-1}$	--
K_4	3	3	μm^{-2}	--
d_f	1	1	s^{-1}	*(3)*
D_f	0.8	0.8	$\mu m^2 s^{-1}$	--
D_m	0.3	0.3	$\mu m^2 s^{-1}$	--
c_5	1	1	s^{-1}	--
K_5	1	1	μm^{-1}	--
d_m	1	1	s^{-1}	--
σ	0.2-0.8	0.005-0.015	$pN\mu m^{-1}$	*(3)*
α	7	0.2	$pN\mu m^{-1}$	--
β	1	1	$pN\mu m^{-1}$	--
τ	2.62	2.62	$pNs\mu m^{-2}$	*(24)*
M	10	10	$pN\mu m^{-3}$	--
A_0	78.3110	78.3110	μm^2	--

"--" means not available in references

Text S1 The incorporation of persistent external stimulus and random internal noise into model system

In our numerical simulations, both the global graded stimuli and local stimuli are introduced into the model system as follows. Since the stimuli only fluctuate the conversion rate from Rac-GDP to Rac-GTP, they are incorporated without altering the conservation of Rac-GTPase.

$$\begin{cases} \dfrac{\partial u}{\partial t} = D_u \nabla^2 u + \left(b + \dfrac{c_1 u^2}{u^2 + K_1^2} + \dfrac{c_2 f^2}{f^2 + K_2^2} + k_s \right) v - ru, & on\ \partial\Omega_0 \quad (SM.1) \\ \dfrac{\partial v}{\partial t} = D_v \nabla^2 v - \left(b + \dfrac{c_1 u^2}{u^2 + K_1^2} + \dfrac{c_2 f^2}{f^2 + K_2^2} + k_s \right) v + ru, & in\ \Omega_0 \quad (SM.2) \end{cases}$$

where k_s denotes the stimulus which is spatially dependent and can be chosen as either the persistent external stimulus k_s^{grad} or random internal noise k_s^{loc}.

When k_s switchs to persistent external stimulus, although the direction of the stimulus can be arbitrarily determined, for simplification, our models assume it is along the horizontal direction with a linear decay from the highest value on one side to zero on the other side of the cell. The plus and minus sign indicates the direction of the stimulus. Eq. 11 in Material and Method section of main text ensures that the graded stimulus exists within cell area during morphological change and migration.