Modeling of eukaryotic cell motility on engineered substrates

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Understanding eukaryotic cell motility is important for morphogenesis, wound healing, immune response, as well as for the development of effective treatment strategies for diseases like cancer and for the design of bio-active surfaces. Substrate-based cell motility is, however, a very complex process as regulatory pathways and physical force generation mechanisms are intertwined. To better understand the interplay between adhesion and force generation, we develop an effective computational model, coupling the dynamics of adhesion site formation to the substrate's response and the cell's shape deformations mediated by the internal dynamics of the cytoskeleton [1,2]. The model reproduces key experimental facts observed for several cell types like transitions from steady motion to intermittent stick-slip motion with concomitant shape oscillations. We explored the cell's motility behavior on a variety of engineered substrates: a step in either adhesion or substrate stiffness, as well as substrates with periodic stripe-patterned adhesiveness. We predict that the direction of motion of cells can switch from parallel to perpendicular to the stripes as a function of both the adhesion strength and the width ratio of adhesive to non-adhesive stripes. This discovery can be used for the design of test assays for cell screening and sorting.

1. F. Ziebert, S. Swaminathan, and I.S. Aranson, *J R Soc Interface*, **9**, 1084 (2012).

2. F. Ziebert and I.S. Aranson, "Effects of adhesion dynamics and substrate compliance on the shape and motility of crawling cells", *submitted to PLOS ONE*, (2013).