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Polymer dynamics and fluid flow in actin-based cell motility

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In living cells, nonequilibrium protein polymerization reactions are frequently used to convert chemical energy into mechanical energy and thereby generate useful force for cellular movements. We have examined the polymer and fluid dynamics in two biological cases where the assembly of branched actin filament networks generates force: the intracellular movement of the bacterial pathogen *Listeria monocytogenes*, and the extension of the leading edge of skin epithelial cells during wound-healing. In both cases, net actin filament assembly occurs at the front of the network structure and net disassembly occurs at the rear. Actin protein subunits and other network components must be recycled through the fluid phase to the front of the polymerizing network in order for forward movement to continue at steady state. For actin-based movement of *Listeria monocytogenes*, we have found that actin recycling is not rate-limiting; instead, the speed of movement is governed by the cooperative dissociation of groups of noncovalent protein-protein bonds attaching the filamentous network to the bacterial surface. In contrast, rapid actin-based extension at the leading edge of moving epithelial cells is associated with unusual perturbations in intracellular fluid flow.