Controlling active gels with addressable soft interfaces

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Living cells feel and respond to the mechanical properties of their environment via the interaction with the constituents of the cellular cortex [1]. As a model system, here, we prepare an active gel from cytoskeletal extracts that we condense onto a soft interface. The addressable anisotropic shear viscosity of this interface allows us to reversibly control the structure and dynamics of the active layer underneath.

The studied active material consists on a network of bundled microtubules (MTs), which are crosslinked and driven by ATP-fueled kinesin motors [2]. In the presence of a soft interface, MTs assemble leading to the formation of a quasi-2d active nematic liquid crystal that features long-range orientational order, although it is constantly permeated by turbulent flows [2]. In our experiments [3], the active nematic is easily commanded by preparing it in contact with a thermotropic liquid crystal, which features Smectic-A (lamellar) phase. Under a uniform magnetic field, the Smectic exhibits an aligned texture at the interface with marked anisotropic viscosity. Under such rheological constraint, the active nematic is rapidly organized in parallel stripes of aligned MT bundles, revealing its intrinsic length- and time-scales, which have been predicted in recent theoretical works [4].

The demonstrated control strategy should be compatible with other viable active biomaterials at interfaces, and we envision its use to condition cell crawling or tissue growth.

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