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Driven Dynamic Patterns of Supported Lipid Bilayers by Standing Surface Acoustic Waves

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The in-plane structuring of lipid membranes not only provides new possibilities for the investigation of biomolecular processes in two dimensions, but also mimics a crucial property of the cell membrane. Here, we present a new tool, which allows to actively generate and control dynamic patterns in 2D supported lipid membranes by using nanoscopic standing surface acoustic shear waves (sSAWs) (a). The SAW couples to the membrane, inducing local accumulations of labelled lipids (b). After switching off the high frequency generator, the pattern decays with a diffusive timescale of seconds (c). Using a very thin piezoelectric substrate, sSAW driven manipulation of supported membranes is combined with high resolution fluorescence microscopy allowing to access the time evolution of driven domain formation, as well as the dynamics of single DNA molecules locally trapped in stripe-like domains on the surface of lipid membranes. Finally, the tool presented does not only extend the concept of supported lipid membranes in basic research, but also offers a variety of practical applications like particle filters over a wide range in size, controlled formation of dynamic cell patterns or single molecule transport with protein separation.