High-Speed force spectroscopy of lipid bilayer rupture

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Supported Lipid Bilayers (SLBs) are simple biological membrane models widely used for fundamental studies. Atomic Force Microscopy (AFM)-based Force Spectroscopy is an ideal technique to investigate the mechanical properties of SLBs at the nanoscale, their elastic constants but also their resistance to failure. The mechanical rupture of the lipid bilayer by the AFM tip has been used extensively as a hallmark of its mechanical stability, usually by measuring the forces required to break the bilayer probed at different velocities. Being a stochastic process, rupture forces generally increases linearly with the logarithm of the loading rate, defining a characteristic dynamic force spectrum. Thanks to the miniaturization of the cantilever and piezoelectric elements, High-Speed AFM (HS-AFM) allows reaching tip velocities in the millimeter per second range with microsecond time resolution (1), covering a wider dynamic force spectrum. Here, we apply HS-AFM Force Spectroscopy to access six decades of indentation velocities on supported lipid bilayers. We also assess the possible contribution of the cantilever resonance frequency to the force spectrum. The preliminary dynamic force spectrum of DOPC SLB can be interpreted with a single energy barrier although possibly followed by an outer state. The outcomes allow us to evaluate the validity of general theoretical developments applied in the field (2).

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2. Butt HJ & Franz V (2002) Rupture of molecular thin films observed in atomic force microscopy. I. Theory. *Physical Review E* 66(3).