

Probing single molecules with AFM: Force, motion, dynamics, and function

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In 1952, Erwin Schrödinger wrote that we would never experiment with just one electron, one atom, or one molecule.¹ Forty years later, methods derived from scanning probe microscopies allowed us to manipulate single atoms and molecules, and even single bonds.² Single molecule force spectroscopy, which consists in trapping and stretching a molecule between an AFM tip and a surface, enables to probe (and/or to induce) molecular processes in situ and in real time through the application of mechanical forces. Such elegant experiments have provided unprecedented insights into the structure and function of many (biological) systems.³

Force, dynamics, and function can now be probed at the single-molecule level, but this exploration of single entities is only in its infancy. Physicists are eager to know whether the phenomena observed at this scale obey the laws we know for ensemble of species or will force us to rethink our understanding of physics. Chemists can now play with single bonds, orient molecules and trigger a chemical reaction between single entities. Biologists and biophysicists are now able to investigate molecular-level processes involved in living organisms, such as muscle contraction, cell locomotion and division, or transport processes. Much of the exquisite and detailed information about how biomolecular machines operate has been gleaned from direct measurements made on single molecules.

Here, we will discuss some of our recent results in the field of AFM-based single molecule force spectroscopy on bio-inspired systems, like the investigation of how small binders perturb the dissociation mechanisms of DNA, single atom exchange in supramolecular polymers, the measurement of the force generated by a synthetic molecular machine and the real time capture of folding/unfolding transitions in synthetic foldamers.⁴

References

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