

Versatile Tools Towards Real-time Single-molecule Biology

Imaging

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Essential biological processes ensuring proper cellular metabolism, imperative to life, are performed by proteins interacting with and processing DNA and RNA amongst other biological matter. Detailed insights into these processes provide essential information for understanding the molecular basis of life and the pathological conditions that develop when such processes go awry.

The next scientific breakthrough consists in the direct, real-time observations and measurements of the individual mechanisms involved, in order to validate and complete the current biological models. In this complex context, single-molecule technologies offer an exciting opportunity to obtain structural and functional information at the molecular level.

Here, we present our efforts in further enabling discoveries in the field of biology and biophysics using a fully integrated optical tweezers with single-molecule fluorescence microscopy technology combined with a microfluidics system. With this powerful technique manipulation and visualization of single molecules is possible with “nm” spatial resolution and “ms” temporal resolution, while “pN” forces can be measured. We present several examples in which these technologies have enhanced our understanding in the field of DNA/RNA structure and their interactions with proteins and in the fields of molecular motors, protein folding/unfolding, cell membranes and genome structure and organization.