

SUPPLEMENTARY DATA

Photonic Force Microscope set-up. Our PFM consists of a custom-built inverted light microscope with a 3D sample positioning stage, an infrared laser for optical trapping, and a quadrant photodiode for high-resolution 3D and time-resolved position detection (Figure S1). The trapping beam is produced by a diode-pumped, ultra-low noise Nd:YAG laser with a wavelength of $\lambda = 1064$ nm (IRCL-500-1064-S, CrystaLaser, USA), and a maximal light power of 500 mW in continuous wave mode. To achieve a high intensity gradient for good trapping efficiency, the effective laser beam diameter is expanded 10 times by a telecentric lens system (EXP, Beam Expander, Sill Optics, Germany). The expanded IR-beam is reflected by a dichroic mirror (DM1, AHF analysentechnik AG, Germany) into the high numerical aperture (NA=1.2) of a 60x water-immersion objective (OBJ, UPLapo/IR, Olympus, Japan), which focuses the laser down to its diffraction limit into the object plane of the microscope and creates the optical trap. The sample is mounted onto a piezo scanning stage (PZT, P-561, Physik Instrumente, Germany) for 3D sample manipulation and positioning, relatively to the fixed optical trapping focus. The PZT with controller (E-710 Digital PZT Controller, Physikalische Instrumente, Germany) has a travel range of 100 μ m along all three dimensions with a precision of ~ 1 nm. The laser light is scattered by the trapped object, collected by a condenser (CND, 63X, Achroplan, NA = 0.9, water-immersion, Zeiss, Germany), and projected by a second dichroic mirror (DM2) onto an InGaAs quadrant photodiode (QPD, G6849, Hamamatsu Photonics, Japan). The QPD is placed in the back focal plane of the condenser and fixed on an x-y translation stage (OWIS, Germany) for manual centering of the detector relative to the IR-beam. To avoid saturation of the QPD, a second neutral density filter (NF2) can be placed in front of the QPD, when maximal laser powers are used for strong trapping. Amplification of the QPD signal is chosen to span the whole 12 bits dynamic range of the data acquisition board (NI-6110, National Instruments, USA). The QPD has a cut-off frequency around 700 kHz. The trapped particle's position was detected in all three dimensions with high precision (~ 1 nm) and with a sampling rate of 500 kHz by recording the interference of the unscattered light and the light scattered by the particle (6). For illumination in the visible, a 50 W halogen lamp is diffused (DIF) and projected by a mirror (M) through the condenser, objective and a 180 mm tube lens (TL) that creates an image of the object plane onto a charge-coupled device camera (CCD, ORCA ER S5107, Hamamatsu Photonics, Japan). The scanning stage, CCD camera, and data acquisition, as well as data analysis and

representation were controlled and coordinated by a specialized software (DataTwister, NiNART, Switzerland).

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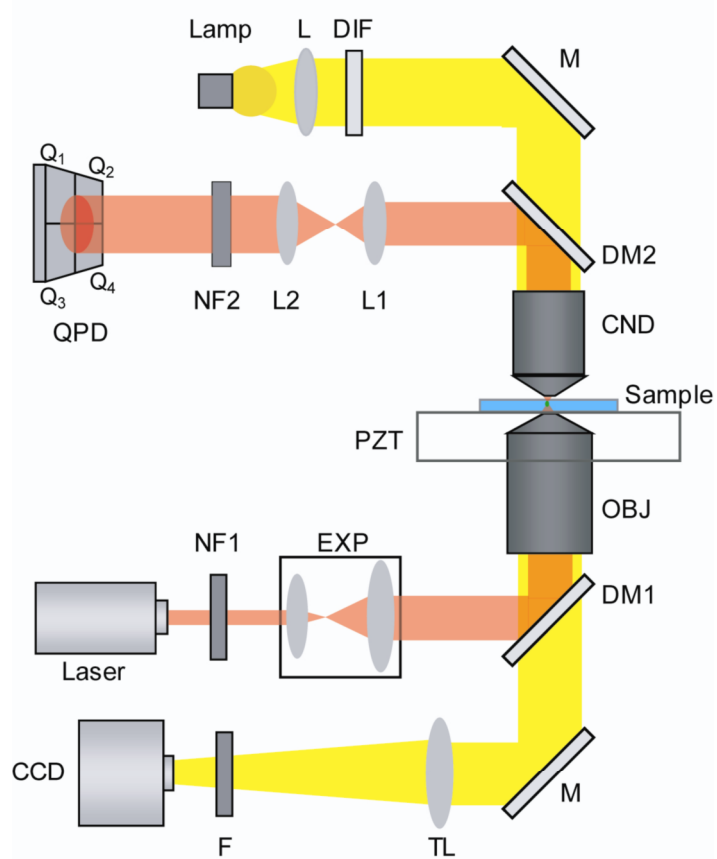


Figure 1S

Figure 1S. Schematic layout of the IR (red) and visible (yellow) light paths. The laser beam is expanded 10 times by a beam expander (EXP) and attenuated if necessary by a neutral density filter (NF1), then reflected by a dichroic mirror (DM1), and focused by the objective lens (OBJ) into the sample chamber, which is mounted on a piezostage (PZT). The scattered IR-light is collected by a condenser (CND), and directed by a second dichroic mirror (DM2) onto the quadrant photodiode (QPD). A second neutral density filter (NF2) is placed in front of the QPD, to avoid possible saturation of the detector. A 50 W halogen light source (Lamp) illuminating the object plane, through a lens (L) and diffuser (DIF), is reflected by the first mirror M but transmitted through both dichroic mirrors (DM1 and 2). The image created by the CND and OBJ is reflected by the second lower mirror (M) and the 180 mm tube lens (TL) onto the charge-coupled device camera (CCD).