An Optically Controlled Microscale Elevator Using Plasmonic Janus Particles

Supporting Information

Spas Nedev, [1,2] Sol Carretero-Palacios, [1,2,3] Paul Kühler, [1,2] Theobald Lohmüller, [1,2] Alexander S. Urban*, [1,2] Lindsey J.E. Anderson*, [1,2] Jochen Feldmann[1,2]

[1]*Photonics and Optoelectronics Group, Department of Physics and Center for Nanoscience (CeNS) Ludwig-Maximilians-Universität (LMU),Amalienstaße 54, 80799 Munich, Germany*
[2]*Nanosystems Initiative Munich (NIM), Schellingstraße 4, 80799 Munich, Germany*
[3]*Instituto de Ciencia de Materiales de Sevilla (CSIC), C/ Américo Vespucio 49, 41092 Sevilla, Spain*

Janus Particle Characterization

Figure S1 shows the white light scattering spectrum of an individual Au/SiO_2 Janus particle in water. The particle was 1.3 μm in diameter with a 5 nm thick gold coating. The spectrum exhibited a broad resonance around 750 nm, but still had substantial interaction with the light used in our experimental set-up (1064 nm).

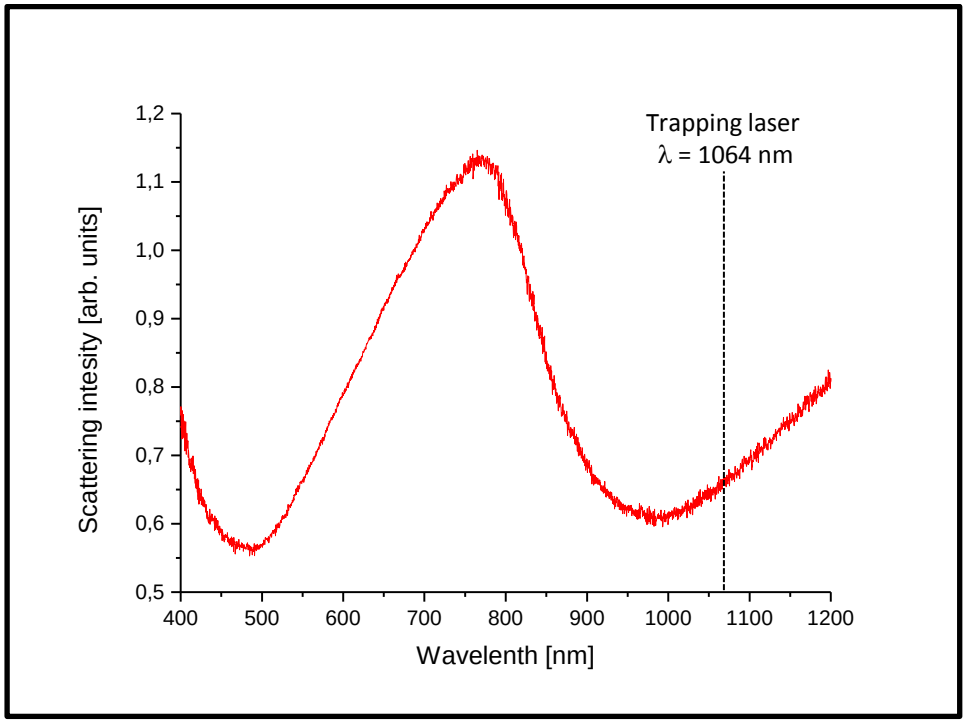

Figure S1 White light scattering spectrum of an individual Au/SiO_2 Janus particle.

For SEM measurements, a Gemini Ultra Plus field emission scanning electron microscope with a nominal resolution of ~2 nm (Zeiss, Germany) was used. The images were collected by the in-lens detector at an electron accelerating voltage of 0.5 kV and a working distance of 1 mm. These settings enable high-resolution imaging of the substrate surface without using a conductive coating.

Inverted Microscope Experiment

Figure S2 shows the force diagram for the inverted microscope experiment. All forces are opposite of the upright case except for gravity. The fact that the elevator also functions in this configuration shows that neither gravity nor convection play a significant role in the microelevator behavior.

$$\vec{F}_{tot} = \left|\vec{F}_{sca}\right| - \left|\vec{F}_{grav}\right| + \left|\vec{F}_{grad}\right| - \left|\vec{F}_{thermo}\right|$$

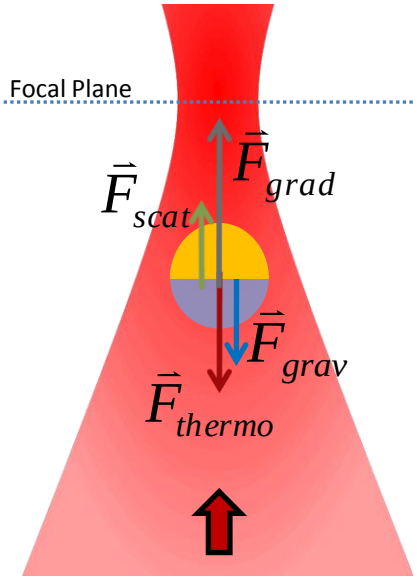

Figure S2 Force diagram for the inverted microscope experiment.

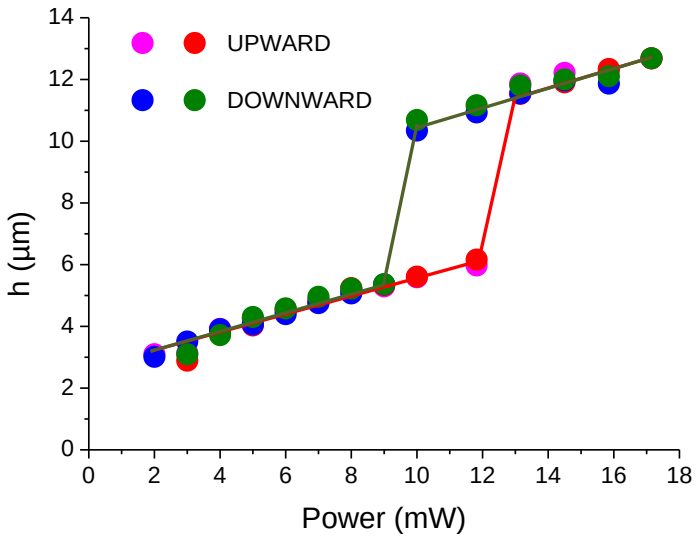

Figure S3 Hysteresis in the upward/downward motion of the Janus particle upon increasing/decreasing the laser power.

Simultaneous Trapping Experiment

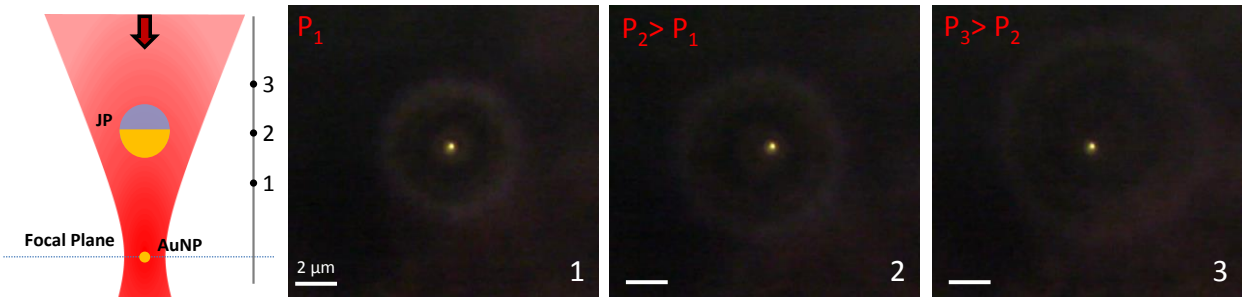

Figure S4 Simultaneous trapping of a Janus particle and an 80nm Au sphere. While the sphere always stays in the same position, the height of the Janus particle varies according to the trapping laser power. Thus the distance between the two particles can be controlled through the trapping laser power.