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Gold nanostructure assisted thermophoretic trapping of single nano-objects

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The manipulation and trapping of nano-objects that undergo Brownian motion are of great interest in soft-matter sciences. Optical tweezing is the most common technique for the trapping of individual particles in solution and is based on the optical gradient force. Hence, a sufficiently high polarizability of the particle in the solution is required. While it is thus easy to trap single dielectric particles larger than 100 nm, a trapping of smaller objects such as single molecules by means of optical tweezers can hardly be realized. Molecular trapping can be achieved by a technique called Anti-Brownian Electrokinetic trap (ABEL trap) [1], which exploits the feedback-controlled electric field of four electrodes. Hence, the latter technique requires electrical contacts, which introduce difficulties when fabricating multiple traps. Here, we present an all-optical technique which replaces the electric fields by highly localized thermal fields. The so-called thermophoretic trap exploits thermophoretic interactions of a particle and a liquid when applying a temperature gradient, which e.g. locally distorts the screening of the surface charges and by that induce a particle drift sufficient for the manipulation of small nanoparticles or molecules [2].

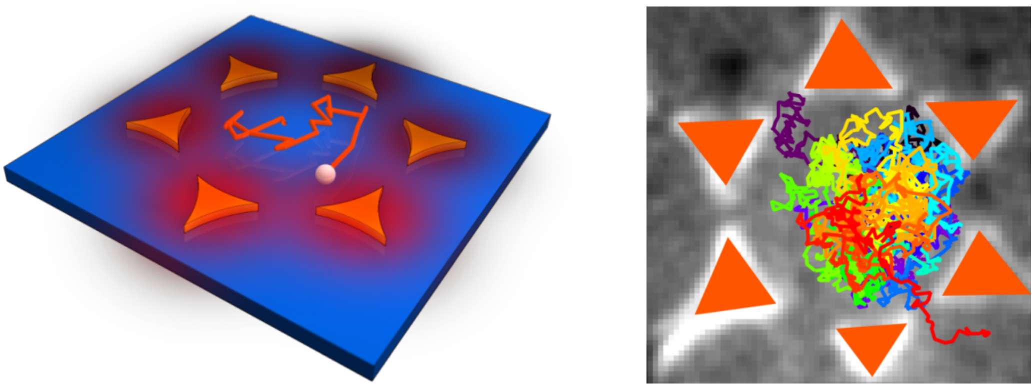

Figure 1: (left) Scheme of the thermophoretic trap consisting out of triangle-shaped Au islands (right) Trajectory of a trapped polystyrene sphere

In our approach the temperature field is generated by optically heated Au nanostructures fabricated by microsphere lithography (Fig. 1) [3]. Due to the small dimensions of the heat sources, even a small temperature increase introduces large temperature gradients causing a strong thermophoretic drift by which the motion of a diffusing particle can be manipulated.

References

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