IMPRS on Multiscale Biosystems

Project description

Title: Light sensitive particles as a model of cellular motion
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In collaboration with: Dr. Mark Santer (MPIKG).

Project description:
In this project we propose a novel mechanism to induce self-propulsion and to manipulate ensembles of micron-sized particles (artificial and biological) trapped at solid-liquid interfaces. This idea is inspired by the so-called phototactic behavior of organisms such as bacteria that show directional motion towards light. For these organisms, of course, a complex chain of biochemical processes is involved, rendering the understanding of the motion mechanism to be rather difficult. A nano-material engineer, however, can attempt to find an optimized solution. Here we want to develop the idea that only one micro-particle could be both, the sensor and the motor at the same time.
The physical origin of our approach is related to so-called light driven diffusioosmosis (Figures 1a and 1b).[1] During irradiation of a solution of azobenzene containing surfactants (Figure 1a)[2] with focused light, there is a formation of local hydrodynamic flow at a solid/liquid interface. The corresponding hydrodynamic forces are sufficient to swiftly clean the illuminated area from particles trapped at the interface (Figure 1c).

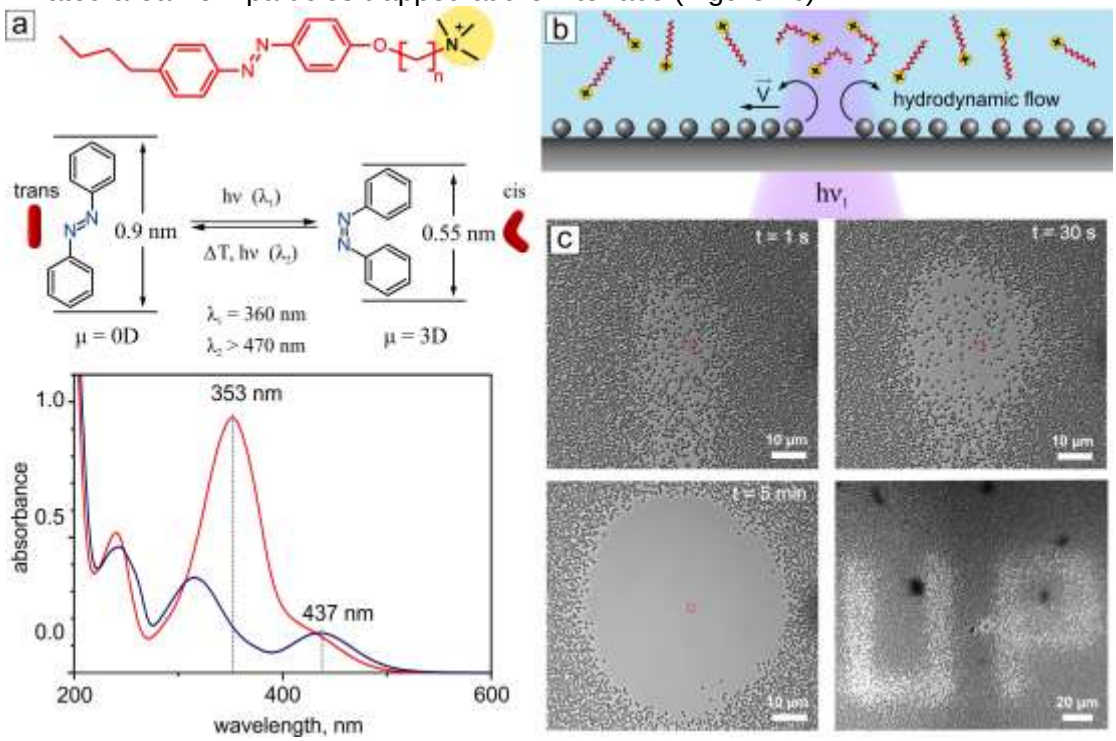

Figure 1. (a) Chemical structure of an azobenzene containing cationic surfactant. Shown below is a scheme of the photo-isomerization of the azobenzene group, together with UV absorption spectra of the molecule in its *trans* state (red) and *cis* conformation (blue) (b) Scheme of the setup, consisting of a micro-channel filled with surfactant-water solution and adsorbed particles. Subsequently, irradiation with UV light is initiated, and a local removal of particles is achieved. (c) Three snapshots (after irradiation time t = 1 second, t = 30 seconds, and t = 5 minutes) documenting successive stages of the “cleansing”. UP (University of Potsdam) logo written within the particles (diameter 2 μm) assembly.

When the colloids are turned into Janus particles, their self-propulsion can be initiated in the solution of azobenzene containing surfactant under global/homogeneous illumination with UV light. With the methodology to be developed in our project we want to establish light-driven hydrodynamics as a useful and versatile tool for investigating collective motion of self-propelled particles and aggregation.

Required background: The prospective student should have a background in chemistry or physical chemistry. Practical experience with analytical and microscopic techniques is advantageous.

References:

(1) Feldmann, D.; Maduar S.R.; Santer, M.; Lomadze, N.; Vinogradova O.I.; Santer, S. «Manipulation of small particles at solid liquid interface: light driven diffusioosmosis» *Scientific Reports*, 6 (**2016**) 36443

(2) Schimka, S.; Lomadze, N.; Rabe, M.; Kopyshev, A.; Lehmann, M.; von Klitzing, R.; Rumyantsev, A.M.; Kramarenko, E.; Santer, S. «Photosensitive microgels containing azobenzene surfactants of different charge» *Physical Chemistry Chemical Physic*s, 19 (**2017**) 108-117

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