

Silica-based Self-propelling Supraparticles Showing Oscillating Motion and Controllable Trajectories

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We present a novel type of mm-sized silica-based self-propelling devices that exhibit homogeneous vertical oscillating motion driven by H_2O_2 as chemical fuel. The supraparticles are prepared via simple droplet templating technique by drying colloidal suspension droplets containing silica microspheres and catalytic $\text{Fe}_3\text{O}_4@\text{Pt}$ decorated nanoparticles on a superhydrophobic Cu-Ag surface. Using Pt catalyzed H_2O_2 decomposition, the produced oxygen sticks to the hydrophobized supraparticle surface. This causes an increase in buoyancy and finally an elevating motion of the particles. Once reaching the surface the oxygen bubble is released and the particle is sinking again. This process then is repeated leading to an oscillating motion that can last for many hours or days. A quantitative model is derived based on the reaction kinetics, particle ingredients and adsorption of oxygen and subsequently applied to experimental data, giving a detailed mechanistic description of this process.

In addition, due to the magnetic properties of the supraparticles, it is possible to manipulate the trajectory by applying a magnetic field, which thereby allows for controlling the motion at will in 3-dimensions. The vertical movement velocity (that can reach up to 30 mm/s) as well as the oscillation interval can be controlled via the concentration of H_2O_2 as well as by changing the particle density. Finally the supraparticles can become further functionalized so that they can perform catalytic reactions during their pathway. This was demonstrated for the example of the decomposition of the iodine-starch complex.

In summary, these supraparticles are a new type of smart functional material on the mm-scale performing controllable 3D movement and showing high versatility considering potential applications as further functional components could become easily integrated into their design.

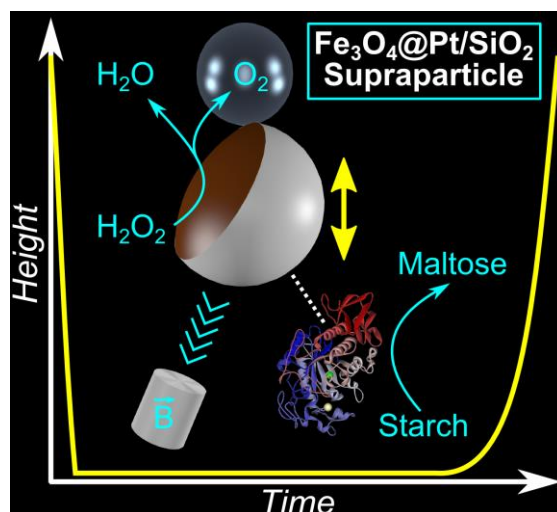


Figure 1 Oscillating self-propelling supraparticle showing magnetic response and potential surface functionalisation for (bio-) chemical reactions [1].

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[1] M. Sperling, H. –J. Kim, O. D. Velez and M. Gradzielski, *accepted in Advanced Materials Interfaces*.