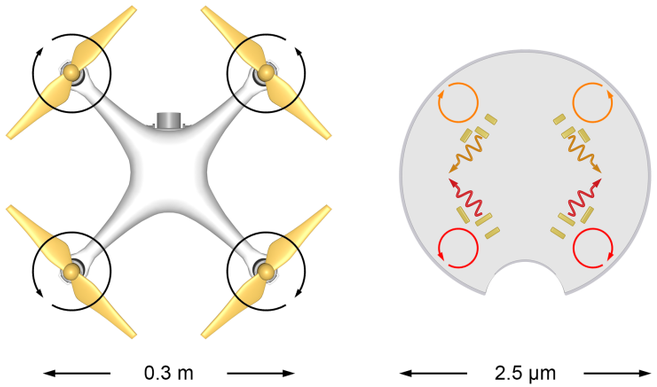
Light-Driven Microdrones

Powered simply and yet precisely by unfocused light, the microdrones move freely in solution – forward, backward, sideways and by rotating around their own axis, just like their macroscopic quadcopter cousins do in the air. This opens up an entirely new approach to the highly targeted manipulation of micro- and nanoscale objects under a microscope – such as transporting molecular and chemical cargos and accessing isolated biological cells from any angle.



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PCT application filed
2022

Potential applications from life sciences to nanotechnology

The highly versatile microdrones' potential encompasses use cases from the construction of tailored nanostructures via the delivery of functional cargos in molecular and reproductive medicine to the manipulation of cell walls by the precise placement of nanoscale heat sources and the high-resolution probing of liquid-solid interfaces.

01 Capture, transport and release of cargos, nanomanipulation, local probing and sensing, etc.

02 Precise, robust and user-friendly steering by simply controlling the light intensity for each nanomotor.

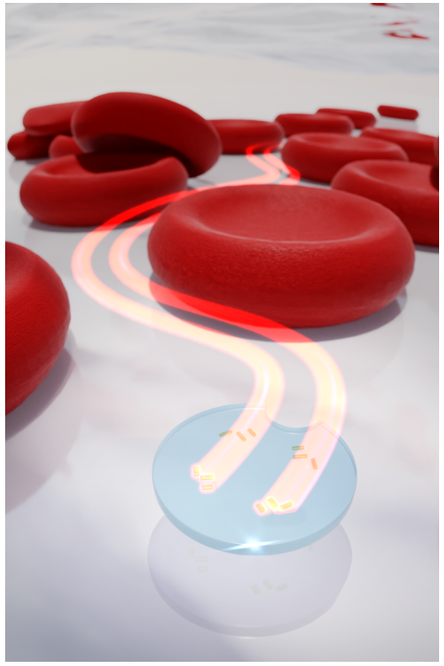
03 More versatile than current optical tweezers and micromanipulators.

04 Prototypes exist and have been experimentally tested; see below for peer-reviewed results.

REFERENCES:

Patent appl. WO2023094369A1

Wu et al. Nat. Nanotechnol. 17, 477–484 (2022).



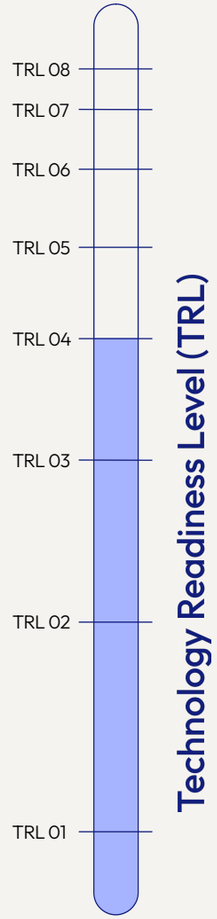
The highly steerable microdrones are significantly smaller than red blood cells (above). Whereas the mode of generating thrust is entirely different, the combined effect of the different nanomotors is conceptually similar to that of the rotors on a quadcopter drone (left).

CHALLENGE

Thanks to optical tweezers, minuscule objects like biological cells and their internal components can be already precisely studied and manipulated. Yet, even this remarkable tool has its limitations. For example, it is hard to change the orientation of a trapped object and thus to access it from several sides, or to make several small objects interact in a targeted manner. As for micromanipulators, these are e.g. limited by their angle of attack and the mechanical connection to the machinery driving them.

INNOVATION

Each microdrone consists of a stiff sheet a few micrometers in diameter. On it are several nanoantennas that each absorb light of a specific wavelength and polarization and re-emit it in a defined direction, thereby pushing the drone itself in the opposite direction. Constructing each antenna to react to a different kind of light, they can thus be individually controlled, simply by varying the intensity of the light sources used to illuminate the drones. Akin to the individual control of the rotors of macroscopic quadcopter drones, this is used to move and rotate the microdrones in any direction.



01 Basic principles observed · **02** Technology concept formulated · **03** Experimental proof of concept · **04** Technology validated in lab · **05** Technology validated in relevant environment · **06** Technology demonstrated in relevant environment · **07** System prototype demonstrated in operational environment · **08** System complete and qualified

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