

“Ungrippable” objects

gripped, moved and positioned safely



Have you ever tried to stack single grains of sand one on top of the other using tweezers or sort pollen dust according to the plant from which it originates? It's hard enough attempting to recognize such minute objects with the naked eye, let alone grasp even tinier nano particles with your fingers or “normal” aids. Yet countless research laboratories frequently face exactly this problem, for instance if human cells no more than a fraction of a millimetre in size have to be picked up or positioned individually.

An international team of researchers led by PD Stefan Thalhammer (Helmholtz Research Centre, Munich) and Professor Mandayam A. Srinivasan (MIT – Massachusetts Institute of Technology, Boston) has succeeded in developing a solution to precisely this challenge based on products designed by nano technology specialists at attocube systems in Munich.

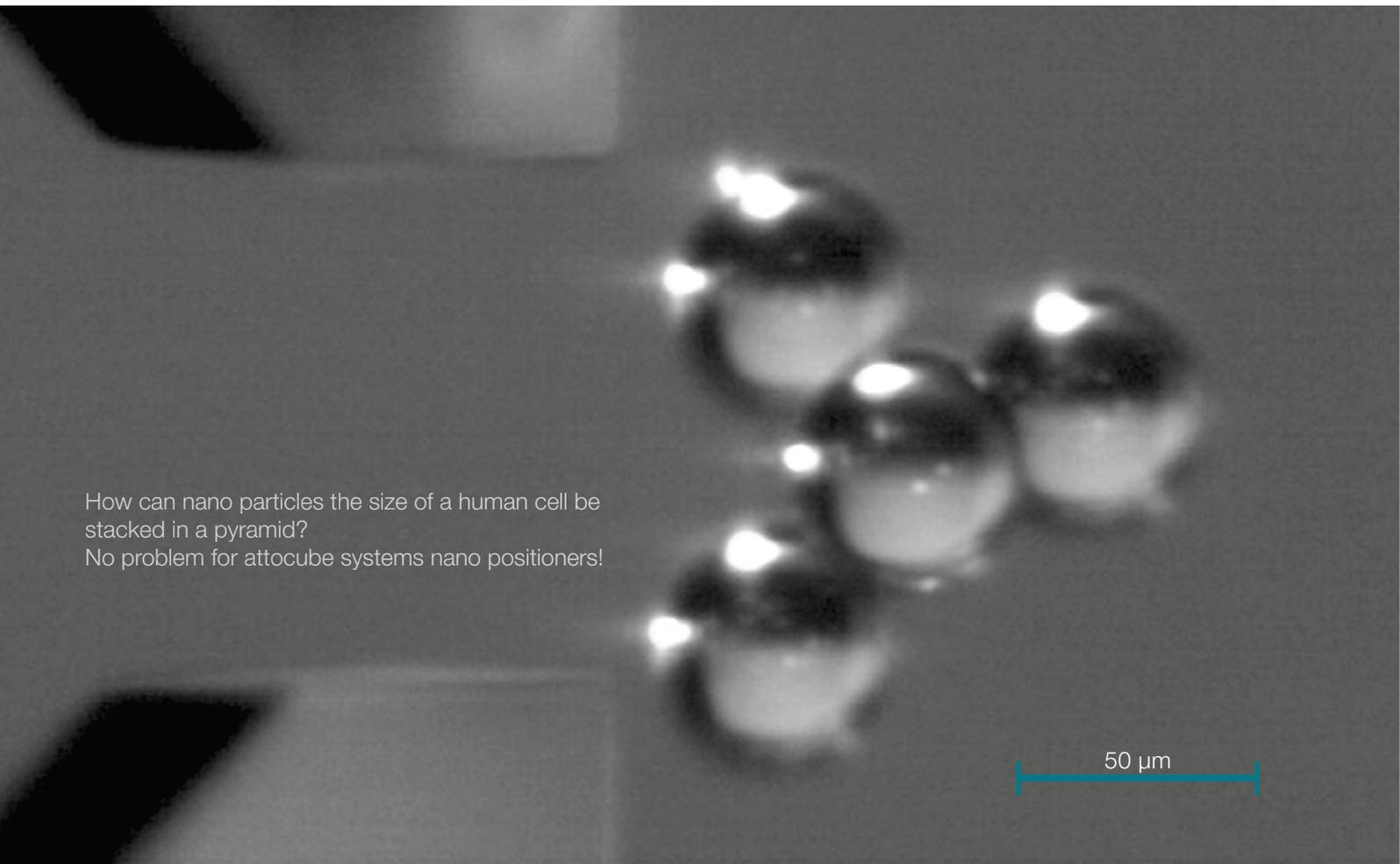
Barely bigger than a dice, these titanium micro motors help researchers examine surfaces and structures with atomic resolution using special microscope systems.

Nano motors made by attocube systems position even the tiniest objects ultra-precisely and extremely flexibly: nanometre xyz coordinates are pinpointed in all three axes while rotating motors locate angles accurately in microdegrees.



attocube systems AG has been part of the WITTENSTEIN Group since 2007. Patented servo motors and interferometer sensors for nano-precise positioning are developed, manufactured and marketed by around sixty experts at its Munich facility. Today, attocube systems is rapidly conquering the industrial market with special micro motors and interferometers to satisfy even the most challenging requirements in micro materials processing, optical technology or semiconductors and life sciences.





How can nano particles the size of a human cell be stacked in a pyramid?
No problem for attocube systems nano positioners!

50 μm

>> **Adaptation of the basic gearhead principle**

This problem was solved by adapting the basic gearhead principle – the obvious approach for attocube systems as a subsidiary of the WITTENSTEIN Group. A gearhead is defined as a complex machine element that enables the three motion quantities – displacement, velocity and acceleration – to be varied independently of one another. The researchers involved in the project used high-precision micro motors made by attocube to develop a so-called micromanipulator: this scales down the movement of a human hand in the centimetre range, allowing objects to be positioned by a gripper with nanometre precision – in the same way as a gearhead converts or reduces motion quantities.

Scaling down the hand movement is only part of the solution, however: in the opposite direction, a force sensor mounted on the gripper provides haptic feedback whenever a particle is picked up, moved and positioned.

This microscopic force is then scaled up again and exerted on the operator's fingers. At the same time, the movement is visualized on a display by means of an optical microscope. It sounds simple but the technology is extremely complex; after all, the particles to be moved are only 10 to 100 μm in size – nano objects much finer than a human hair.

Precise access using a joystick

The micromanipulation system firstly comprises a haptic interface, activated by the sense of touch, in the form of a joystick. The interface detects the movement of the human hand and sends it to the micromanipulator's controller. This second system module is responsible for moving the micro-gripper in all three dimensions and adjusting its angle. These movements are executed by micro motors made by attocube systems. The force and displacement information is integrated and evaluated in an arithmetic unit. The electronics used

Invisible to the naked eye – yet meanwhile grippable under a microscope thanks to attocube technology: these nano beads are no more than 50 μm in diameter while human cells measure just 10 to 20 μm .



The haptic feedback provided by the joystick tells the researchers when the gripper makes contact with the nano particles. The gripper is controlled by the attocube positioners with nano precision in all three dimensions. A rotator (right) enables the gripper angle to be adjusted.

to control the gripper motions were also provided by attocube. A stereo microscope simultaneously records the position of the objects and detects when they are picked up or moved, enabling these events to be visualized on the display. The operator is supported not only visually but also haptically: the joystick is programmed so that a resistance is felt as soon as the cell is gripped.

This results in a totally intuitive, realistic “look & feel” that makes it difficult to believe that the objects being moved are not normal sized particles but nano.

Awards for excellence in nano technology

attocube systems enjoys an excellent reputation in the world of nano technology. The Munich company provides a working environment in which innovative ideas can prosper and advanced technology be developed under ideal conditions. One key reason for this inspirational atmosphere is that the firm’s sixty or so strong team – physicists, engineers, chemists, IT specialists, product developers and designers – work side by side with colleagues from seventeen different countries.

The fact that when an idea is put into practice, its author accompanies the new product from development right through to marketing additionally contributes to a good innovation climate. It comes as no surprise to learn that attocube systems has already won numerous accolades for its achievements, including the German Startup Award and the Bavarian Innovation Award. The latest honour was conferred only three months ago: on July 5, 2013 Ranga Yogeshwar, journalist and presenter of the “Wissen vor 8” (Knowledge Before 8) science programme on German television, congratulated Dr. Dirk Haft, founder and CEO of attocube systems AG, on being named runner-up among the nation’s most innovative small and medium-sized enterprises as he handed him the “TOP 100” Innovation Seal of Approval.



attocube founder Dr. Dirk Haft is presented with the “Top Innovator 2013” award by science journalist Ranga Yogeshwar.