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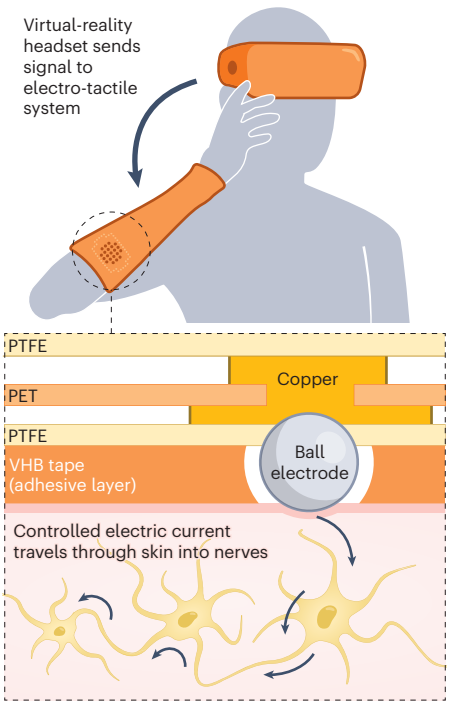
Pushing boundaries on an international scale

Cross-border collaborations draw on diverse strengths, driving innovative approaches to nanoscience. These three papers are among the most highly cited for leading institutional collaborations with international partners for nano-related research. **Data analysis by Bo Wu. Infographic by Bec Crew, Tanner Maxwell, David Payne and Benjamin Plackett**

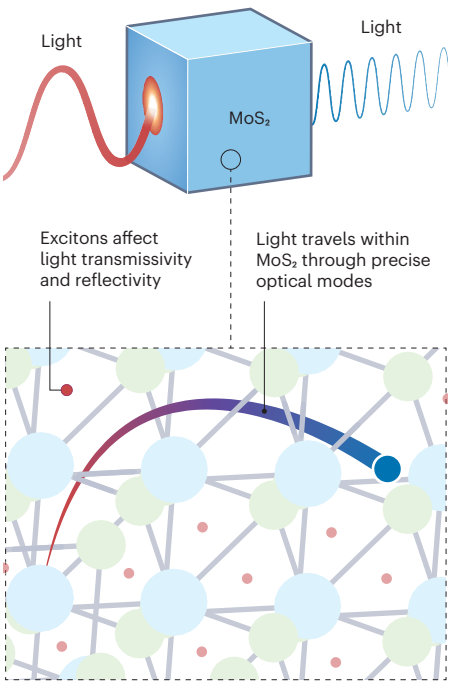


STRONG SENSE

***Chinese Academy of Sciences**, China (Nano rank: 1)
Georgia Institute of Technology, United States (53)

There are drawbacks to ways that virtual-reality users experience feeling. Mechanical stimulation, such as a device touching the skin, is energy intensive, and electrical stimulation (a voltage jolt to the skin) presents safety concerns. A team led by the Chinese Academy of Sciences, in Beijing, and Zhong Lin Wang, from the Georgia Institute of Technology in Atlanta, with colleagues at Peking University, tested a self-powered electro-tactile system on 10 volunteers. By controlling the distance between the electrode and skin, the nanogenerator adjusts the current to be pain-free. Layers of PTFE (polytetrafluoroethylene) and PET (polyethylene terephthalate) contain and direct the current. The device could be used to help Braille users and could also enable astronauts to feel through gloves (Y. Shi *et al. Sci Adv.* **7**, eabe2943; 2021).

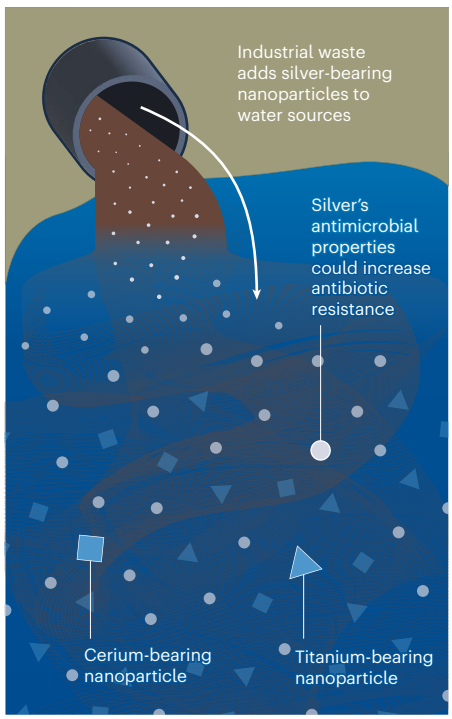
*The Chinese Academy of Sciences is an umbrella organization that administers multiple member institutions.



IN LIGHTS

National University of Singapore, Singapore (14)
Shenzhen University, China (49)

A physical phenomenon known as 'bound states in the continuum' (BIC) occurs when a material reflects no light, instead perfectly trapping it within its nanostructures. Nanoscientists want to get as close to BIC as possible without reaching it, so they can channel light out of the material with high precision. Researchers, led by Cheng-Wei Qiu from the National University of Singapore with collaborators from Shenzhen University in China, used a thin layer of molybdenum disulfide (MoS_2) and embedded it with excitons (atom-like particles made from the excited state of electrons) and a high density of optical modes (paths of light). This allowed them to achieve quasi-BIC light emissions, a technique that could have applications in sensors, medical imaging and other technologies (N. Muhammad *et al. Nano Lett.* **21**, 967–972; 2021).



TANNER MAXWELL

MURKY WATERS

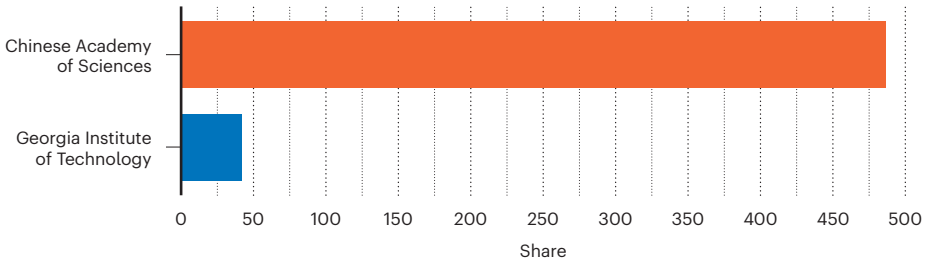
French National Centre for Scientific Research, France (11)
Spanish National Research Council, Spain (110)

As nanotechnology industries grow, nanoparticle pollution might increase. Researchers at the French National Centre for Scientific Research and Spanish National Research Council gauged levels of cerium-bearing, silver-bearing and titanium-bearing nanoparticles in Barcelona's waterways. Silver-bearing nanoparticles were linked to waste-water treatment plants, whereas cerium and titanium were chiefly attributed to natural sources, except for a few industry hotspots. Concentrations were not deemed toxic, but scientists worry that silver-bearing nanoparticles could increase antibacterial resistance owing to their antimicrobial properties (J. Sanchís *et al. Environ. Sci. Technol.* **54**, 3969–3978; 2020).

STRONG SENSE: PARTNERSHIP ANALYSIS

Shown for both partner institutions are Share in nanoscience and nanotechnology in 2021 and Collaboration Score (CS) of the partnership during the period 2015–21. Although the Georgia Institute of Technology has roughly 10 times less Share than its partner, the Chinese Academy of Sciences, it contributes to one-third of the partnership.

Share in nanoscience and nanotechnology, 2021



Collaboration Score, 2015–21

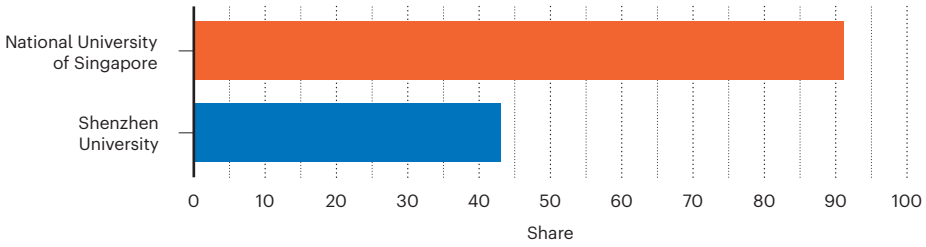
169.93
Chinese Academy of Sciences

85.17
Georgia Institute of Technology

IN LIGHTS: PARTNERSHIP ANALYSIS

Shown for both partner institutions are Share in nanoscience and nanotechnology in 2021 and Collaboration Score (CS) of the partnership during the period 2015–21. The National University of Singapore has several partnerships with Chinese institutions in the leading international collaborations.

Share in nanoscience and nanotechnology, 2021



Collaboration Score, 2015–21

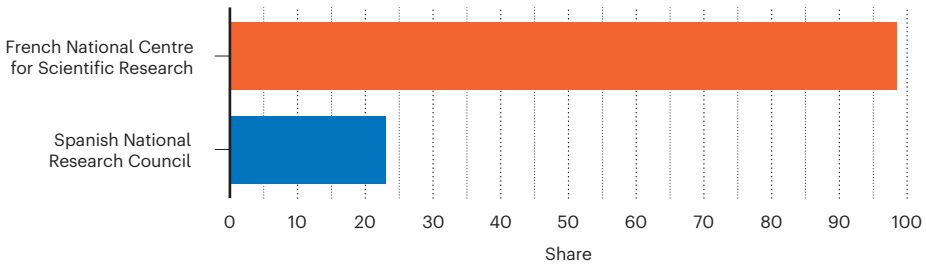
32.55
National University of Singapore

15.51
Shenzhen University

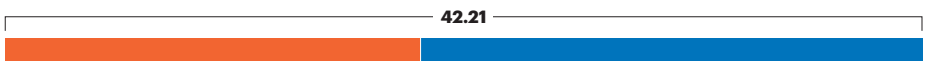
MURKY WATERS: PARTNERSHIP ANALYSIS

Shown for both partner institutions are Share in nanoscience and nanotechnology in 2021 and Collaboration Score (CS) of the partnership during the period 2015–21. Although it has less Share in 2021 than its partner institution, the Spanish National Research Council contributes more to the partnership.

Share in nanoscience and nanotechnology, 2021



Collaboration Score, 2015–21



19.13
French National Centre for Scientific Research

23.07
Spanish National Research Council

SOURCE: NATURE INDEX