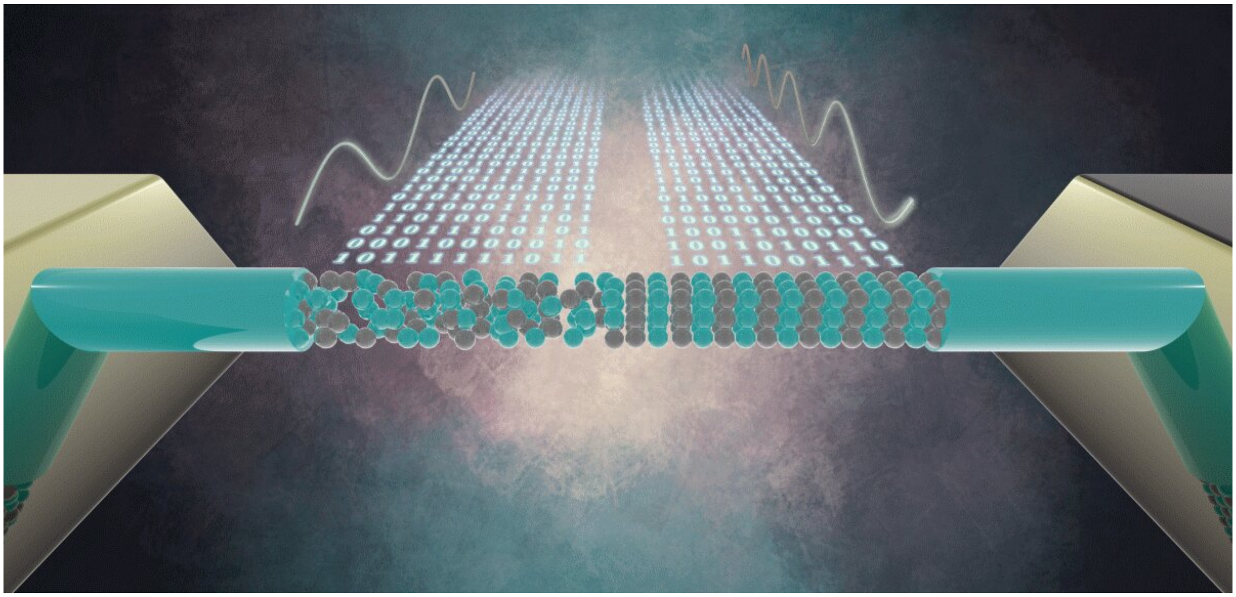
Researchers develop the world's first power-free frequency tuner using nanomaterials

March 18 2022



Power-free frequency tuner illustration. Credit: Utku Emre Ali

In a paper published today in *Nature Communications*, researchers at the University of Oxford and the University of Pennsylvania have found a power-free and ultra-fast way of frequency tuning using functional nanowires.

Think of an orchestra warming up before the performance. The oboe starts to play a perfect A note at a frequency of 440 Hz while all the other instruments adjust themselves to that frequency.

Telecommunications technology relies on this very concept of matching the frequencies of transmitters and receivers. In practice, this is achieved when both ends of the communication link tune into the same frequency channel.

In today's colossal communications networks, the ability to reliably synthesize as many frequencies as possible and to rapidly switch from one to another is paramount for seamless connectivity.

Researchers at the University of Oxford and the University of Pennsylvania have fabricated vibrating nanostrings of a chalcogenide glass (germanium telluride) that resonate at predetermined frequencies, just like guitar strings. To tune the frequency of these resonators, the researchers switch the atomic structure of the material, which in turn changes the mechanical stiffness of the material itself.

This differs from existing approaches that apply mechanical stress on the nanostrings similar to tuning a guitar using the tuning pegs. This directly translates into higher power consumption because the pegs are not permanent and require a voltage to hold the tension.

Utku Emre Ali, at the University of Oxford who completed the research as part of his doctoral work said:

"By changing how atoms bond with each other in these glasses, we are able to change the Young's modulus within a few nanoseconds. Young's modulus is a measure of stiffness, and it directly affects the frequency at which the nanostrings vibrate."

Professor Ritesh Agarwal at the University of Pennsylvania, who collaborated on the study first discovered a unique mechanism that changed the atomic structure of novel nanomaterials back in 2012.

"The idea that our fundamental work could have consequences in such an interesting demonstration more than 10 years down the line is humbling. It's fascinating to see how this concept extends to mechanical properties and how well it works," said Professor Agarwal.

Professor Harish Bhaskaran, Department of Materials, University of Oxford who led the work said:

"This study creates a new framework that uses functional materials whose fundamental mechanical property can be changed using an electrical pulse. This is exciting and our hope is that it inspires further development of new materials that are optimized for such applications."

The engineers further estimate that their approach could operate a million times more efficiently than commercial frequency synthesizers while offering 10 to 100 times faster tuning. Although improving the cyclability rates and the readout techniques is a necessity for commercialization, these initial results might mean higher data rates with longer-lasting batteries in the future.

"Real-time nanomechanical property modulation as a framework for tunable NEMS" is published in *Nature Communications*.

More information: Utku Emre Ali et al, Real-time nanomechanical property modulation as a framework for tunable NEMS, *Nature Communications* (2022). DOI: 10.1038/s41467-022-29117-7

Provided by University of Oxford

Citation: Researchers develop the world's first power-free frequency tuner using nanomaterials (2022, March 18) retrieved 23 April 2024 from https://techxplore.com/news/2022-03-world-

power-free-frequency-tuner-nanomaterials.html