Researchers develop Si-based super-high frequency nanoelectromechanical resonator

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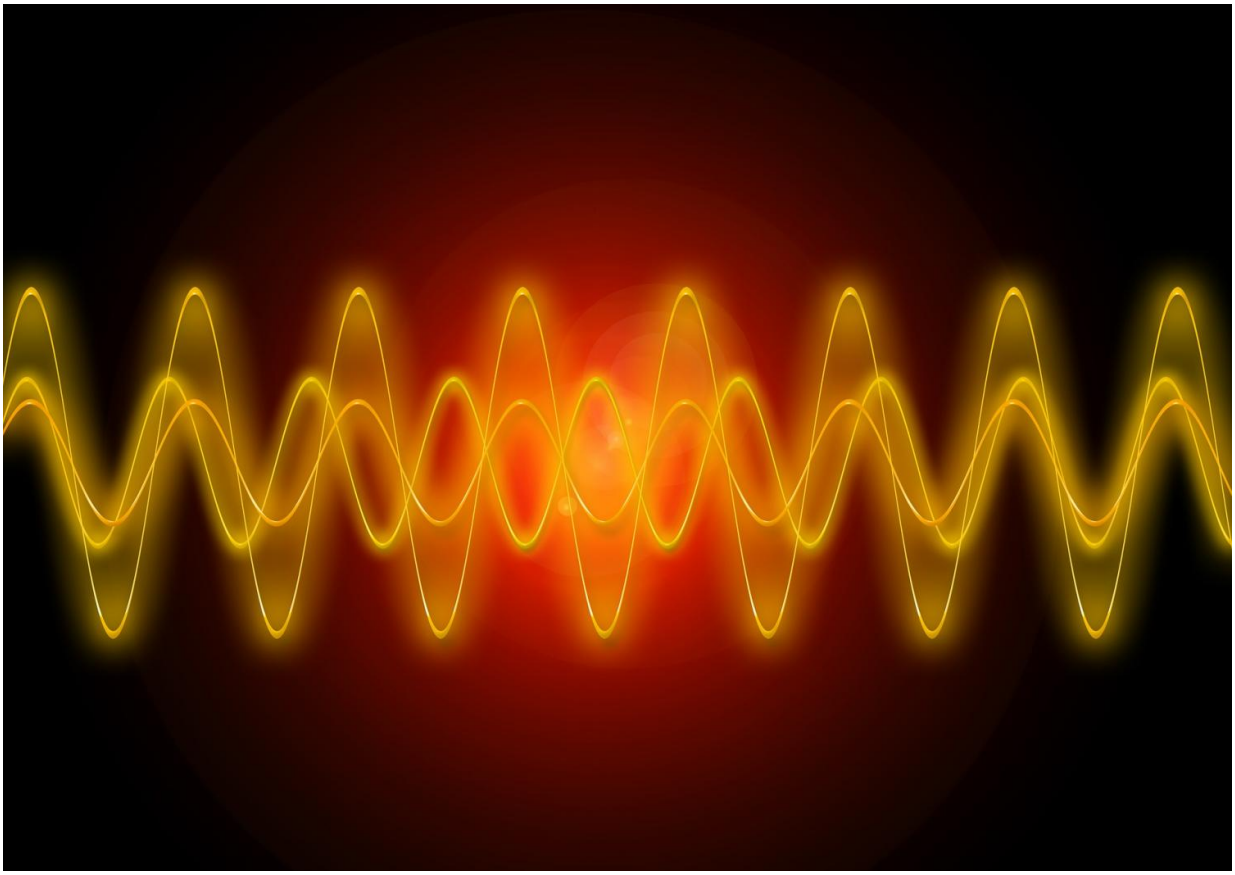

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Silicon single-electron/hole transistors (SETs/SHTs) and super-high frequency nanoelectromechanical resonators show great potential in

quantum computation, sensing and many other areas.

Recently, a group led by Prof. Guo Guoping from the University of Science and Technology of China of the Chinese Academy of Sciences, collaborating with Prof. Zhang Zhen's group from Uppsala University, Sweden, designed and fabricated CMOS-compatible suspended SHT devices which worked as super-high frequency nanoelectromechanical resonators. The work was published in *Advanced Materials*.

The researchers developed the devices using standard complementary metal-oxide-semiconductor (CMOS) fabrication technology, which is convenient for large-scale integration. The observed Coulomb diamond transport features confirmed the formation of SHT.

When suspended, the SHT can also work as a super-high frequency nanoelectromechanical resonator, demonstrating excellent mechanical properties. At ultra-low temperature and under high vacuum, the device showed single-hole tunneling behavior and a mechanical resonance at a record high value of 3 GHz.

These properties will be helpful for exploring the interactions between mechanical vibrations and charge carriers, and investigating potential quantum effects.

Besides, the researchers found that the electrical readout of the mechanical resonance mainly relied on piezoresistive effect, and was strongly correlated to single-hole tunneling. In the SHT regime, the piezoresistive gauge factor was an order of magnitude larger than that at other different driving powers. This property can be applied to study the piezoresistive effect of silicon in nanoscale and more novel mechanical sensing devices' design.

More information: Zhuo-Zhi Zhang et al, A Suspended Silicon

Single-Hole Transistor as an Extremely Scaled Gigahertz Nanoelectromechanical Beam Resonator, *Advanced Materials* (2020). DOI: 10.1002/adma.202005625