Nanowires have superior electrical, mechanical properties and can be put to good use in pressure sensors

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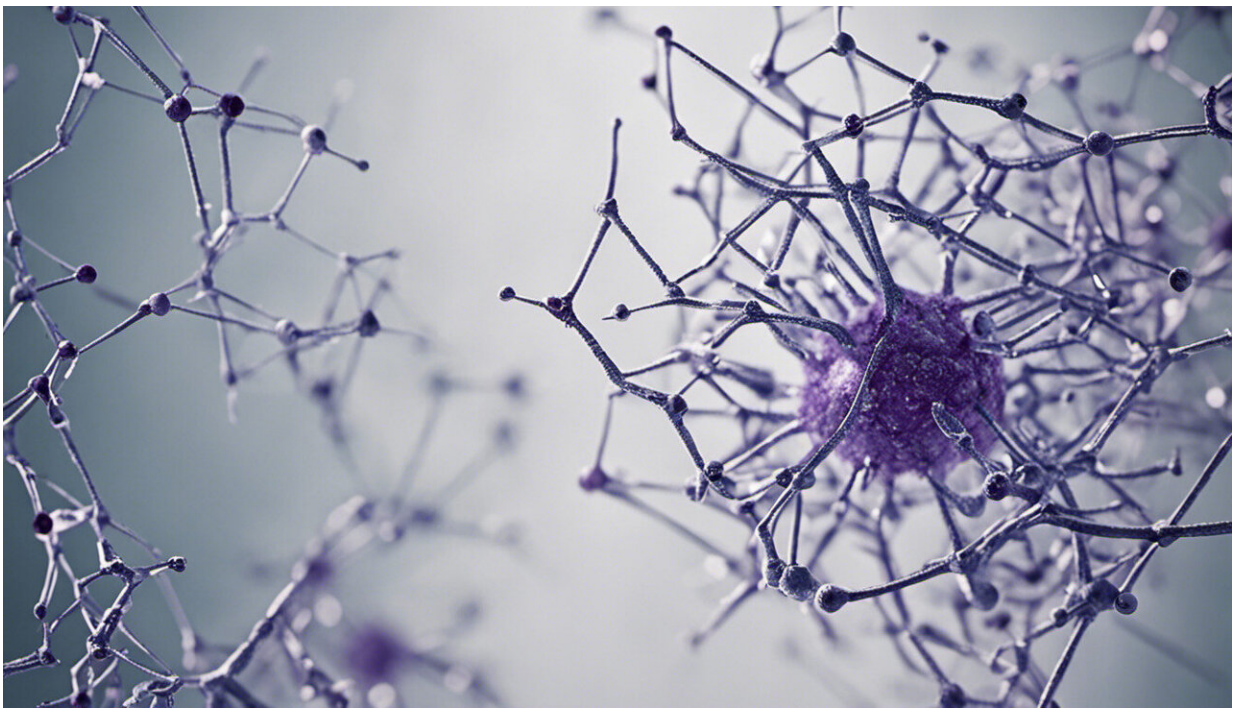

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Miniaturized pressure sensors are widely used in mechanical and biomedical applications, for example, in gauging fuel pressure in cars or in monitoring blood pressure in patients. Woo-Tae Park and co-workers at the A*STAR Institute of Microelectronics1 have now developed a

nanowire-based sensor that is so sensitive it can detect even very low pressure changes.

Most miniaturized pressure sensors harness the intrinsic properties of piezoresistive materials. A structural change in such a material, induced for example by an external force, results in a complementary change in its electrical resistance. However, piezoresistive materials have two major limitations. Firstly, these materials are not particularly sensitive, which means that low pressures produce weak electronic signals. Secondly, these materials can generate a lot of electrical noise, which can mask the true measurement signal. An ideal transducer should have a high signal-to-noise ratio (SNR). Park and his co-workers have now used nanowires to create a pressure sensor with enhanced SNR properties.

Previous research has shown that nanowires can exhibit high piezoresistive effects because of their small size. To take advantage of this, Park and his co-workers used state-of-the-art material processing techniques to suspend two silicon nanowires between two electrodes on a silicon-on-insulator substrate. Each wire was a few hundred nanometers long and approximately 10 nanometers wide. They were covered in amorphous silicon which both protected them and acted as an electrical connection, referred to as the gate. The researchers attached to this a circular diaphragm: a two-layer membrane of silicon nitride and silicon dioxide. Any stress in the diaphragm was therefore transferred to the nanowire structure.

The team characterized their sensor by passing a controlled stream of air across it. Ammeters measured the current flowing through the device as a known electrical potential was applied across the two electrodes. An additional voltage, the gate bias, was also applied between one of the electrodes and the gate. Park and his co-workers demonstrated that they could achieve a four-fold increase in pressure sensitivity by reversing the direction of this gate bias. This, they believe, is a result of the bias

voltage controlling the confinement of the electrons within the nanowire channels — a concept commonly employed in so-called field-effect transistors. An assessment of the device noise characteristics also showed significant improvements with the right choice of operating parameters.

Park and his co-workers believe that the device provides a promising route for applications requiring miniaturized pressure sensors that use little power.

More information: Research article in Journal of Micromechanics and Microengineering

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