Team develops gas-sensing technology that could revolutionize environmental and medical diagnostics

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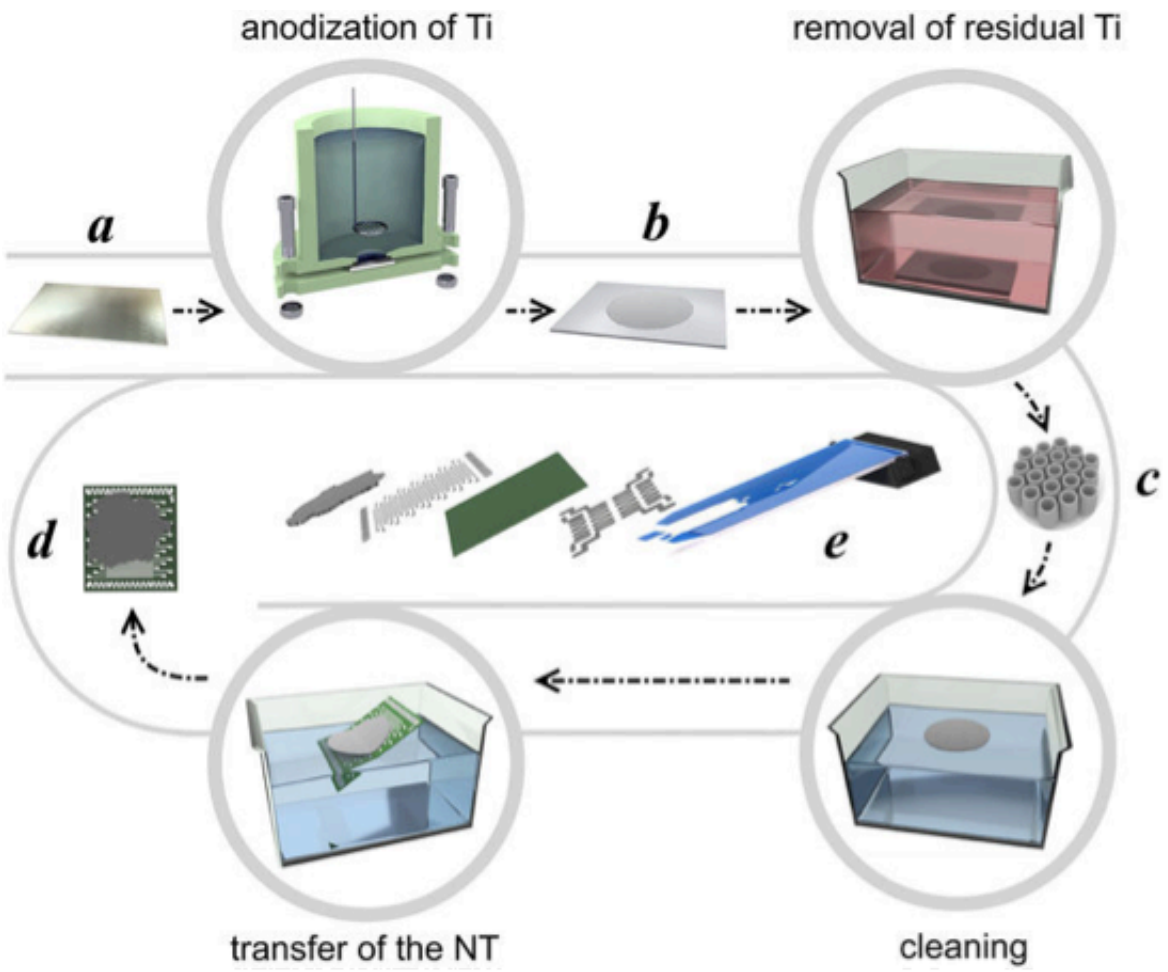

The scheme of fabrication the multisensor chip based on TiOx NT array: (a–e) denote respectively Ti foil (a), Ti foil with as-prepared NT array (b), the extracted NT array (c), the NT array placed over the chip (d), the scheme of multisensor chip wired into 50-pin ceramic card (e) Credit: *Scientific Reports*

Relying on nanotechnology, scientists from Russia and Germany led by Skoltech research scientist Fedor Fedorov have developed an innovative solution for detecting traces of gas in the air.

Given the growing global population, humanity is in urgent need of accurate and affordable gas sensors that can reliably monitor the state of the atmosphere. The ideal gas sensor would be highly sensitive and selective, enabling it to detect even the lightest traces of certain types of substances in the air. It would also be inexpensive to produce and energy efficient.

At present, most gas sensors are made of transition metal oxides, carbon materials (graphene, carbon nanotubes) and various polymers. Despite the obvious progress in increasing the sensitivity of such sensors, inadequate selectivity remains a key problem. Furthermore, there is always a need for new technologies that are compatible with modern electronics. Scientists from several universities in Russia and Germany teamed up to address these challenges.

As a result of their research, they have developed a nanotechnological solution for creating a highly sensitive and selective sensor. These new sensors consist of arrays of nanotubes made of titanium dioxide. They chose titanium dioxide because it exhibits good chemiresistive properties; its resistance level varies with the appearance of gas vapors in the atmosphere.

The device is able to identify substance types by dividing a given material into segments and processing the obtained vector signal using pattern recognition techniques. This enables it to create a fingerprint of sorts for each type of gas it detects. In addition to its environmental impact, this device could prove effective in helping doctors diagnose

illnesses. When people have certain diseases like diabetes or cancer, their breath contains abnormally high amounts of organic gases, particularly acetone. The gas sensor would be able to detect these abnormalities in patients.

The technology is inexpensive and scalable for modern electronics. The technology involves soft chemistry methods to fabricate the nanotubular array, which is then transferred onto the chip to serve as a sensitive layer. "During our laboratory studies, we were able to test the response of our system to acetone, isopropanol and ethanol. The latter two gases are very similar to each other. We were we able to detect these gases and to distinguish them from one another. To do this, we trained our system to identify the appearance of a gas by its 'fingerprint,'" said Fedorov. The results of the study have been published in *Scientific Reports*.

More information: Fedorov, F., Vasilkov, M., Lashkov, A., Varezhnikov, A., Fuchs, D., Kübel, C., … Sysoev, V. (2017). Toward new gas-analytical multisensor chips based on titanium oxide nanotube array. *Scientific Reports*, 7(1), 9732. doi.org/10.1038/s41598-017-10495-8

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