Multifunctional Nanodevice Based on Ti_2O

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Miniaturization of microelectronics, as integration of increasingly more transistors and hence functions per chip area, approaches its end due to the limits of the silicon technology. We propose a new concept of multifunctional nanodevices which multiple functionality is at the material's level, as replacements for common transistors. An example of such a multifunctional nanodevice based on a Ti_2O monolayer will be presented. In contrast to TiO_2 crystal, Ti_2O has not been intensively investigated even though the crystal was fabricated in 1953 for the first time. Our study based on density functional theory indicates that a Ti_2O layer is bistable for two lattice parameters, being metallic for one and semiconducting for another parameter. In a switching configuration, this provides a high current ON/OFF ratio of 103 when the layer is biased and stretched simultaneously. The electronic conductance of the layer is highly anisotropic. The high sensitivity of conductance to layer stretching can be utilized for electromechanical switching, the bistability provides potential for application as a nonvolatile memory bit, while the current-voltage characteristic of the material in its semiconducting phase indicates a possible use as a varistor – all in a single nanodevice.

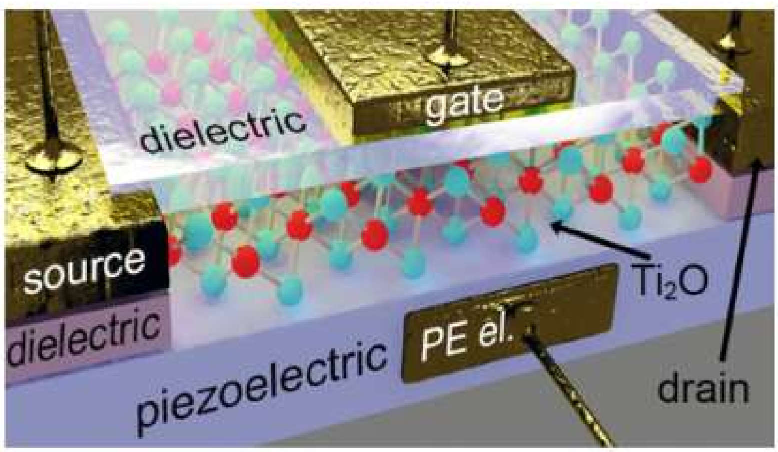

FIGURE 1. Illustration of the multifunctional device based on a Ti_2O monolayer

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