Sensing up to 40 atm Using Pressure-Sensitive Aero-GaN

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This work reports on the fabrication and characterization of a robust pressure sensor based on aero-GaN. The ultraporous aeromaterial consists of GaN interconnected hollow micro-tetrapods with the wall thickness of about 70 nm. The inner surface of hollow micro-tetrapods contains an ultrathin film of ZnO genetically related to the sacrificial template used for epitaxial deposition of GaN. The pressure sensing measurements disclose a nearly linear dependence of the electrical conductance versus applied pressure up to 40 atm, a stable state signal being attained after an interval of about 10 s.

Aeromaterials, such as aerogels, represent three-dimensional ultra-lightweight extra-porous materials formed by randomly distributed networks of nanostructures having different sizes and shapes, such as nanowires, nanotubes, or nanosheets.[1] There is a rather limited number of materials that can be prepared as aeromaterials, but this number is continuously increasing, especially for carbon-based nanomaterials, such as carbon nanotubes, graphene, aerographite, etc.[2–5] This tremendous development of aeromaterials is related to an impressive number of applications in energy storage and conversion (e.g., supercapacitors and solar cells),[6] environmental protection (e.g., large absorption of crude oil, sensors),[7,8] biological applications (e.g., drug delivery, tissue engineering, implantable devices, and biosensing).[9] An interesting application is electromagnetic shielding where ultra-lightweight aeromaterials could replace the heavy metals used for this purpose in many industries, such as automotive and aerospace ones.[10] For many applications, pressure sensors should be robust under strongest accelerations and vibrations, additionally, for aerospace applications they need to withstand radiation, aggressive chemicals, and vacuum.

Recently, we have created a new type of aeromaterial, namely of aero-GaN or aerogalnite,[11] which can be potentially exploited for the applications mentioned above. GaN has been claimed to be a "next silicon" because of the extraordinary development of various applications of this semiconductor compound in high-frequency devices, power electronics, and optoelectronics.[12] Moreover, GaN has a large piezoelectric coefficient, useful in micro- and nano-electromechanical systems[13] and surface-acoustic-wave sensors,[14] and can be used in biological

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