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Ultra-sensitive and selective hydrogen nanosensor with fast response at room temperature based on a single Pd/ZnO nanowire

OlegLupan, VasilePostica, FrédéricLabat, IlariaCiofini, ThierryPauporté, RainerAdelung

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Abstract

In this work the gas sensing properties of nanosensors fabricated by a "bottom-up" approach in a FIB/SEM system based on a single Pd modified ZnO nanowire is investigated in detail. Synthesis, surface doping and functionalization of ZnO nanowires (NWs) with Pd (Pd/ZnO) in a one – step process were performed during electrochemical deposition. The influence of the diameter of the NW, the operating temperature and the humidity are studied in detail and corresponding sensing mechanisms are proposed. An increase in the gas response by a decrease of the NW diameter was observed. Also, by increasing the operating temperature to 200 °C an enhancement in the hydrogen gas response of about 3.5 times (from ≈400 to 1440 to 100 ppm) was obtained and was attributed to the increased catalytic properties of the Pd nanoparticles (NPs). However, long-term investigations revealed a lowered signal stability of the nanosensor operated at higher temperatures. Thus, one can conclude that operation at room temperature is more efficient for real applications, due to the higher reliability of the nanodevices. The presented results demonstrate the importance of nanosensor applications and their high flexibility. The very low current values in the passive regime (in the range of pA – nA) and a very small dimension of the device results in an ultra-low power consumption, which is a key aspect for battery powered handheld instruments.