175 Gas sensors based on non-crystalline carbon nanotube arrays

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In this work we present the characterization and performance of a gas sensor comprised of non-crystalline carbon nanotubes (CNTs) synthesized by chemical vapor deposition (CVD) on porous alumina membranes (CNTs/AAO) as template. Figure 1(a) shows a sketch of the gas sensor, and 1(b) is a lateral SEM image of porous alumina template.

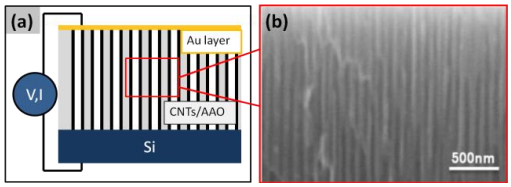

Fig.1 *(a) Scheme of the device. A voltage between top and bottom electrode induces a current through the tubes. (b) SEM image shows the side view of the AAO used as a template and frame of the apparatus.*

The synthesized CNTs are 65 nm of external diameter and 0.5-3.0 μm in length. Since wall thickness of CNTs depends on synthesis time [1], we explored the electric transport mechanism of these devices looking for a CVD-time dependence of the sensors conductance. We studied the behavior of conductance by performing conductance (DC) curves around zero bias as a function of temperature (from 10 K to 310 K) for each sample.

The dominant electronic transport mechanism for these samples is the 3D Variable Range Hopping. This mechanism is usually found in non-crystalline materials [2]. Figure 2 is a plot of the parameter "T_0" (obtained by 3D hopping fitting) as a function of synthesis time for different CNTs length. This model explains satisfactory the transport in CNTs of thin wall (less time of CVD), but it is not enough to explain the behavior of thicker wall devices (20, 25 and 30 minutes of CVD).

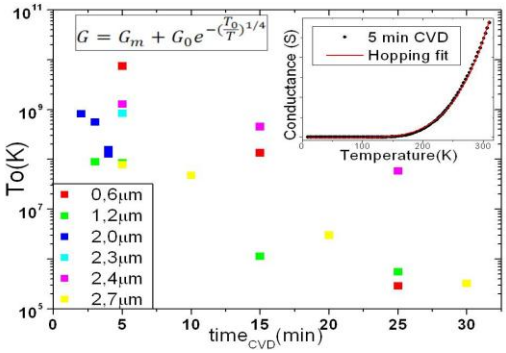

Fig.2 *Conductance as a function of temperature was fitted to 3D hopping transport model, obtaining different T_0 values for each device.*

To evaluate the performance of the device as gas sensor, a sample with 5 minutes of CVD was exposed to acetylene (and Hydrogen). About 4% (3%) of sensitivity was observed in a 10% Acetylene (Hydrogen) / 90% Argon environment. Notice that the sensitivity depends on direction and magnitude of the applied voltage. All devices present a p-type behavior (transport by holes) and according to M. Kumar et al. [3] investigation, we expect that metallic nanoparticles inside the CNTs will improve the sensitivity.

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