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### **Evaluation of the thesis work by Robert Olejnik**

Robert Olejnik has published 15 manuscripts in international journals and presented his work in several national and international meetings.

The main field of work is the assembly of nanomaterials alone or with polymers to produce systems with interesting technological properties, to be used in gas sensors, mechanical sensors, polymer reinforcements, etc. While nanomaterials (e.g. carbon nanotubes) have unique properties as individual entities, the use in a real world, even in micrometric sized devices, requires the transfer of those properties to systems several order of magnitudes larger. From the technological point of view, such transfer is imprescindible to produce real applications. The work of R. Olejnik show significant advances towards this goal.

First, he implemented different fabrication techniques for carbon nanotubes and related materials: i) fabrication of a entangled web of carbon nanotubes by filtering with a electrospinned polymer membrane; ii) fabrication of an electrospinned membrane using a polymer solution with dispersed nanotubes. Both methods allow to produce polymer nanocomposites by compression molding of the polymer fibers. Additionally, a free standing film carbon nanotubes (buckypaper) was produced. The fabrication methods use mainly carbon nanotubes as nanomaterial, but porous carbon microparticles or carbon nanofibers were also used. Additionally, the surface properties of carbon nanotubes were changed by chemical oxidation or plasma treatment.

The materials have been characterized thoroughly, both in its chemical nature, using surface spectroscopies, and in its morphology, using different microscopies. Then, the effect of mechanical strain, presence of vapours and temperature was evaluated.

Finally, using the fabrication methods, macroscopic gas sensing devices were produced and it was shown that the sensitivity depends on the surface properties of the nanotubes and the polymer matrix.

It was found that covering with poly(methylmethacrylate) makes the layer more sensitive to vapours of afine polarity and surface oxidation of the nanotubes make the device more sensitive to polar compounds. Mechanical sensors were built by imprinting the nanotube web inside a polyurethane thick layer by compression molding. The surface properties of the CNT also affect the

sensitivity of the sensor due to the interaction between the polymer matrix and the nanotubes. The gauge factor increased greatly making the nanocomposite with oxidized nanotubes one of the most sensitive known.

The quality of experimental results is very good. The data has been processed using different models, including statistical ones, which allows to find out the underlying mechanisms of external parameters effects.

In summary, the work has been highly succesfull in relating the intrinsic properties of the nanomaterials with the macroscopic properties of real devices. A better understanding of the mechanisms relating external parameters with maasurable properties has been achived. Based on that knowledge, several interesting technological devices have been built.

Therefore, I consider the results published as completely apt to fulfill the requirements of a doctoral thesis.



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