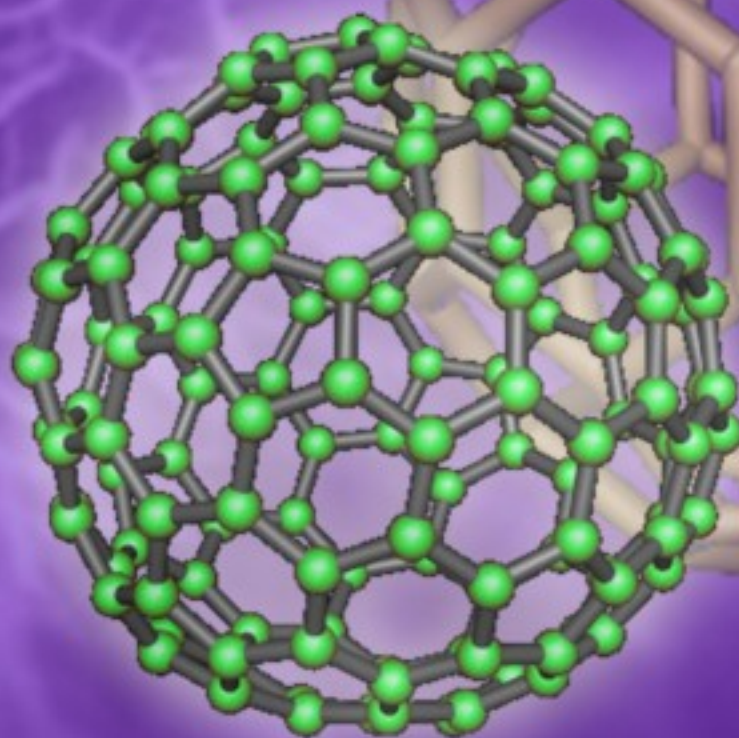
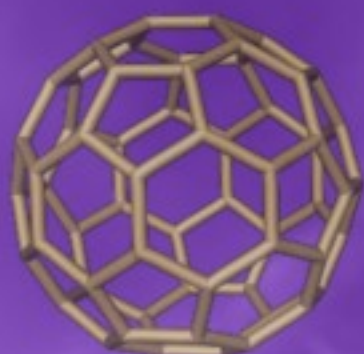


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Hydrogen Sensor Based on Carbon Nano-tube Fortified by Palladium

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Abstract: In this paper single-wall carbon Nano-tubes (SWNT) were prepared by using chemical – Thermal vapor deposition method and utilizing molybdenum and iron catalysts and silica alumina – base. Methane was passed over catalyst in optimum condition including passing speed equal to 4 lit/min and pressure of 1.27 bar for 2-25 minutes and temperature of furnace was equal to 980 °C and prepared carbon Nano-tubes were sublimated in 1600 °C to achieve 70 % yields. Diameter and specific area of Nano-tubes were 2-15 nm and 400-560 m²/g respectively. Various quantities of palladium chloride were inserted in carbon used for prepared Nano-tubes by utilizing vacuum evaporation which its optimum quantity was 0/10 g in order to enhance sensitivity of carbon Nano-tubes relative to hydrogen to make sensors appropriate for low temperatures. For investigation instruments and determining physical properties, XRD, AFM, SEM and TEM equipments have been applied and prepared. Hydrogen sensor is simple, low cost and ready to use in various environment. Copyright © 2009 IFSA.

Keyword: Hydrogen sensor, Carbon Nanotube and Palladium.

1. Introduction

By discovering carbon Nano-tubes (CNT) during 1991-1993, a nonstop investigation was initiated on chemical and physical properties of this type of carbon Nano-tubes by studying *Raman* spectrum of carbon Nano-tubes. However, based on vibration and electronic characteristics on hybrid allotropy (pure sp² and sp³) basis of graphite and diamond was cried out. Nevertheless, issues relevant to strong

and special vibration of Raman have been studied. In addition to Raman spectroscopy, several microscopic efforts may be beneficial for determining selective properties of carbon Nano-tubes including TEM (transmission electron microscopy), SEM (scanning electron microscopy) which are applied for determining carbon morphology of single-wall carbon Nano-tubes (SWNT) (2-5). In this paper, we used evaporation method for penetrating palladium in carbon Nano-tubes. Increasing palladium in carbon Nano-tubes results in enhancing sensor sensibility to hydrogen gas, and also its utilization in low temperatures. Concentration of penetrated palladium in carbon Nano-tubes is proportional to sensibility of sensor toward hydrogen gas.

2. Experimental

After growing single-walled carbon Nano-tubes with chemical vapor deposition (CVD), we took (TEM) and found diameter of tubes are about 1-15 nm, then we examine Raman Spectroscopy and compared it with other references and found that it have 3-4 peaks and compared it with graphite Raman Spectroscopy and found that graphite has only one peak in 1582 cm^{-1} but single-walled carbon nanotubes have two peaks in this region one in 1573 cm^{-1} and one in 1573 cm^{-1} the first one corresponds to D mode and second corresponds to P mode completely conformed with single-walled carbon nanotubes (SWNT) and then we made one cylinder bulk of single-walled carbon nanotubes.

All the common chemicals were on analytically grade and were commercially available. The water used in all experiments was twice distilled with quartz heating tube. A model Cambridge stereo scan 360 scanning electron microscopy (SEM) of nanotubes. A model Philips FEG 200 kv transmission electron microscope (TEM) was used to take photo of nanotubes fragments. A model Hall Effect Oxford Instruments-august 1992, A model Raman spectroscopy Almega Dispersive Raman manufactory Thermo Nicolet Made in USA, was used.

Chemical vapor deposition method involves thermal decomposition of hydrocarbons (usually CH_4) at temperatures ranging from 500 to 1000 °C in the presence of a catalyst containing transition metals such as Fe and Mo. This process, which is more energy efficient than the electric arc-discharge and laser ablation methods, is ideal to generate well-defined structure of nanotubes. The yield and structure of nanotubes are affected by the type, purity and porosity of the catalyst. It has been shown that methane CVD process can be used to obtain ca. 200 % yield (2 g of SWNT /g catalyst) of high quality carbon nanotubes. The methane CVD process shows promises for long-scale production of defect free carbon nanotubes.

Carbon nanotubes produced in a typical process are closed ended and are usually associated with other carbonaceous species such as nanoparticles, fullerenes and catalyst.

After preparing single walled carbon nanotubes in order to mounting palladium and increasing sensibility of carbon nanotubes relative to hydrogen gas in low temperatures, palladium chloride was applied.

Palladium chloride was selected in various quantity and mounted by certain amounts of carbon of single wall nanotubes by using vacuum evaporation, and then were investigated by utilizing metallurgic optical microscope and SEM and optimum quantity of palladium chloride required to be mounted on carbon nanotubes found to be 0.1 g.

3. Results and Discussion

Single-walled carbon nanotubes provided from CVD and used from them for review of sensitivity properties in SEM spectrum observed and clearly have seen exist of single-walled carbon nanotubes under 50 nm, since SEM device in researchment is in limit of 50 nm then we can not used from it for determine of correct dimension and done reviews. TEM spectrum sample of single-walled carbon nanotubes and anything reason is more observed that carbon nanotubes have provided in about 8 nm for next studies and reviews (12).

Note that have seen obviously on different sample by TEM that seed scales of catalyst have essential role in status and grow of single-walled carbon nanotubes. Anything seed scales of catalyst from Gel-cell way are smaller and about nanometer, provided single-walled carbon nanotubes samples will be desirable by scale. In image clearly scale of single-walled carbon nanotubes is about 8 nm.

XRD of carbon nanotubes that curve show carbon nanotubes with seed scales about nanometer.

Raman spectrum of carbon nanotubes that review of it determines curves of type D that first state is related to single-walled carbon nanotubes and next curve is marker of acidic corrosion in surface of carbon nanotubes (12).

The scanning electron microscopy (SEM) photograph of the sensor materials sintered at 980 °C and sublimated at 1600°C indicated that the porosity and grain size of carbon nanotubes significant increases. (SEM) photograph revealed (Fig. 1) qualitative the carbon nanotubes with palladium has greater and larger number of pores. The AFM Photograph (Fig. 2) from the AFM image of carbon nanotubes with palladium in the layer. By taking image from different parts of the surface and driving the average size of carbon nanotubes with palladium particles in each image by foregoing software and average size particles in each sample was calculated, and the mean particle size is about 20 nm. The particle are packed closely and well distributed on the disk. The size and morphology of the particles were characterized by TEM as shown in (Fig. 3) the uniformly of nano powder was confirmed by TEM observation.

The evaluation of the response and recovering characteristics has been carried out. The dc resistance in hydrogen gas alternatively helped to establish the response and recovering characteristics. The result (Fig. 4) show that the invariant resistance in hydrogen gas with time (s). Response and recovering times are 95 (s) and 130 (s) respectively.

4. Conclusion

In this paper, a summary of single walled carbon nanotubes provided and prepared by CVD method in area of 2-15 nm based on Sol-Gel catalyst. Device studies show desirability of sintered materials and ability applications, In review of provided Raman, XRD spectrums, study of Hall effect phenomena and conductivity of provided single-walled carbon nanotubes that can have very well of repeatability, high-level purity of material and development and bring ability of application in most of industries. Carbon nanotubes were activated by palladium through utilizing vacuum evaporation. AFM photo shows grain size of particles that rang 15-30 nanometers. Studying and investing carbon particles and sensor sensibility and AFM photo shows that decreasing grain size of carbon in nanotubes and palladium amounts leads to increase grain size of particles and sensibility of sensors (13-15).

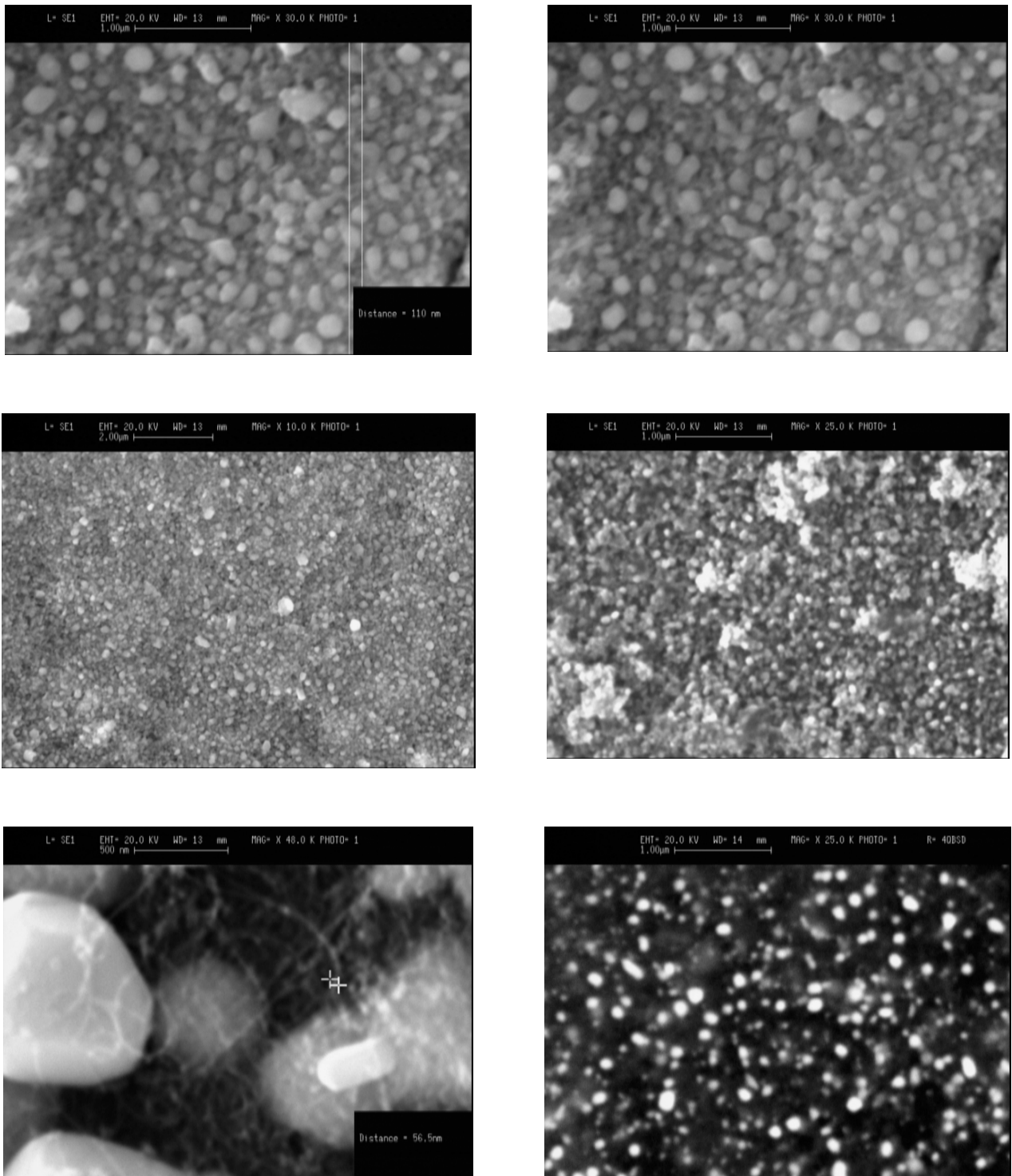


Fig. 1. SEM Photograph before and after adding palladium.

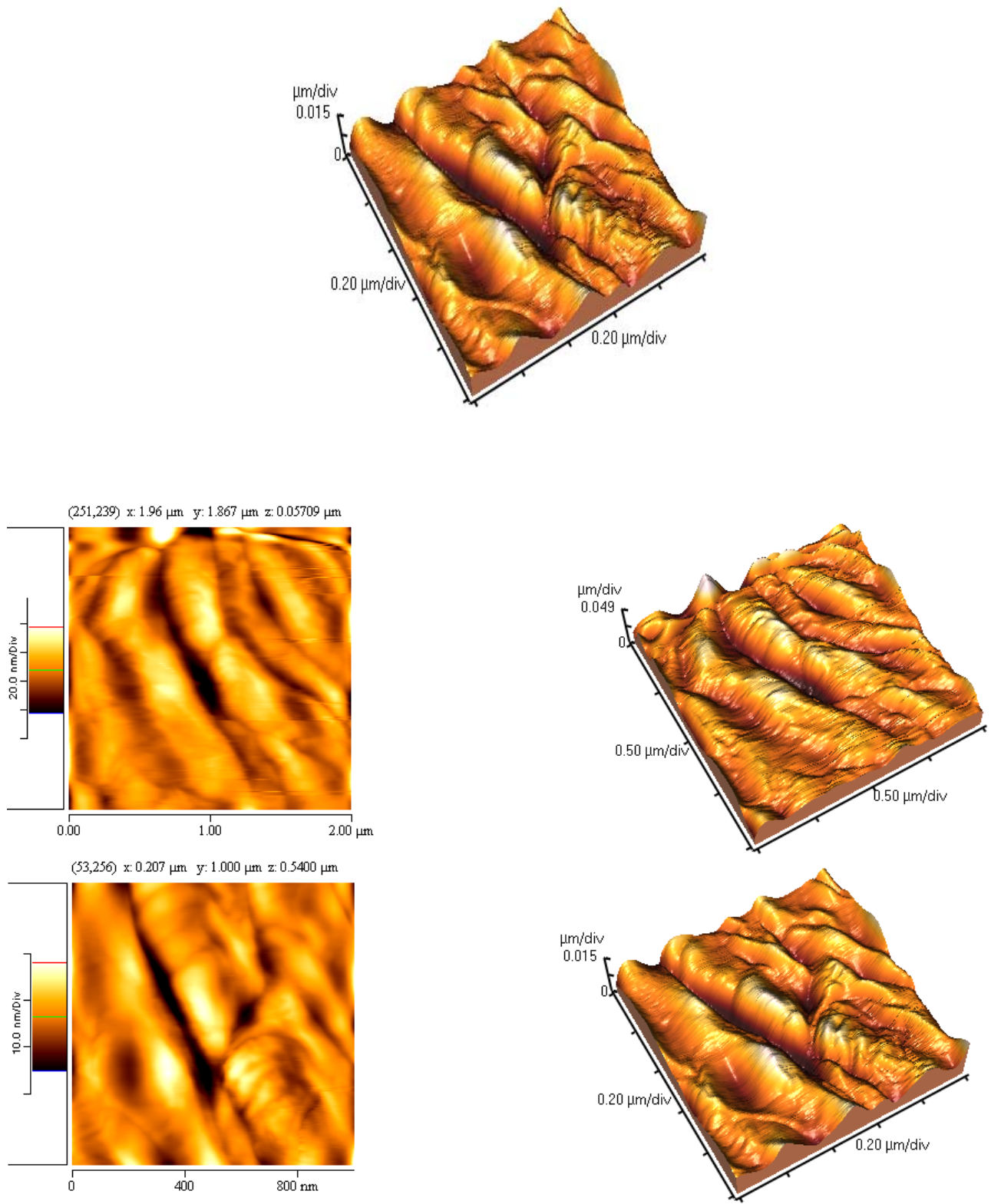


Fig. 2. AFM photograph of carbon nanotube with palladium.

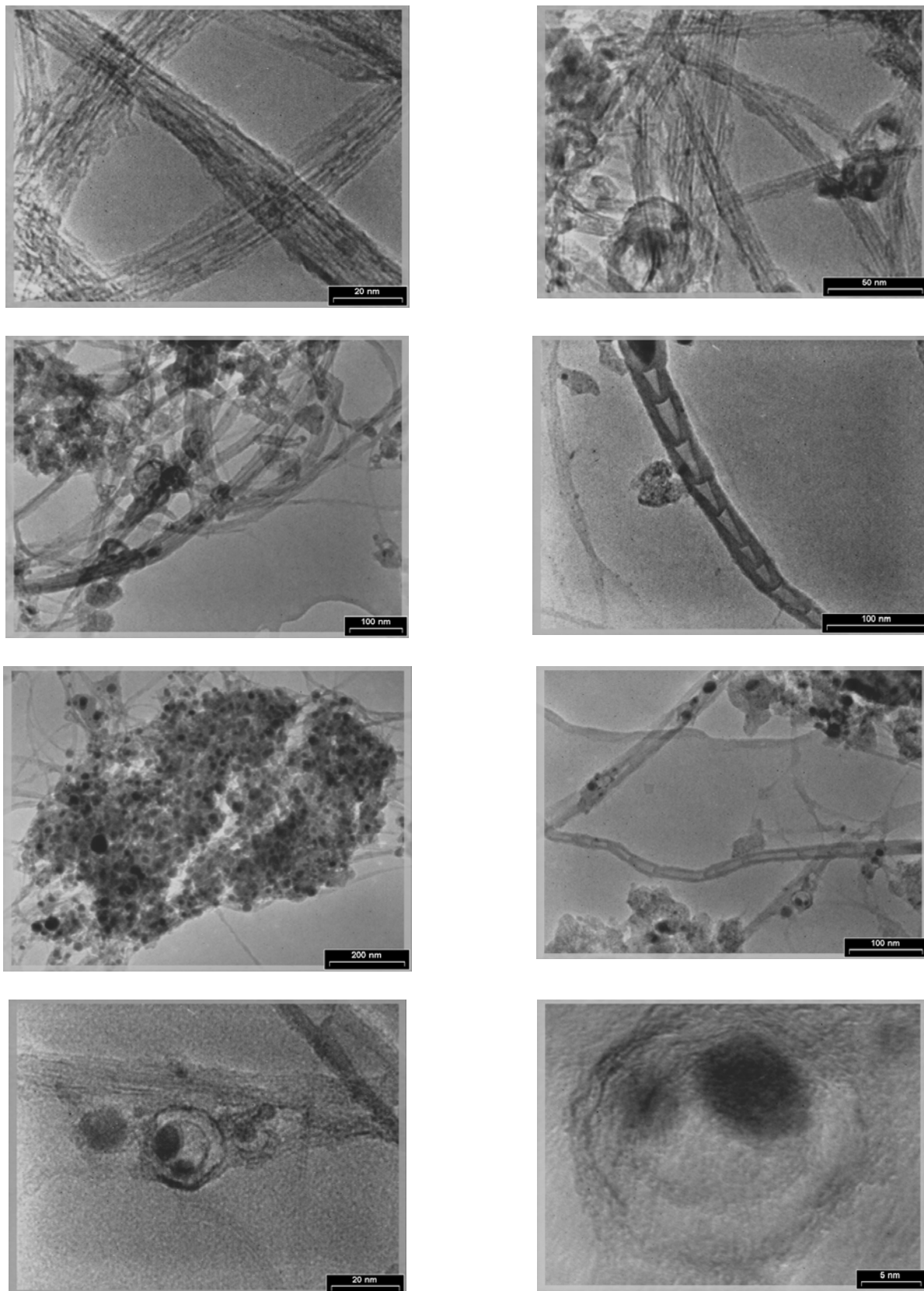


Fig. 3. TEM photograph of carbon nanotyube with palladium.

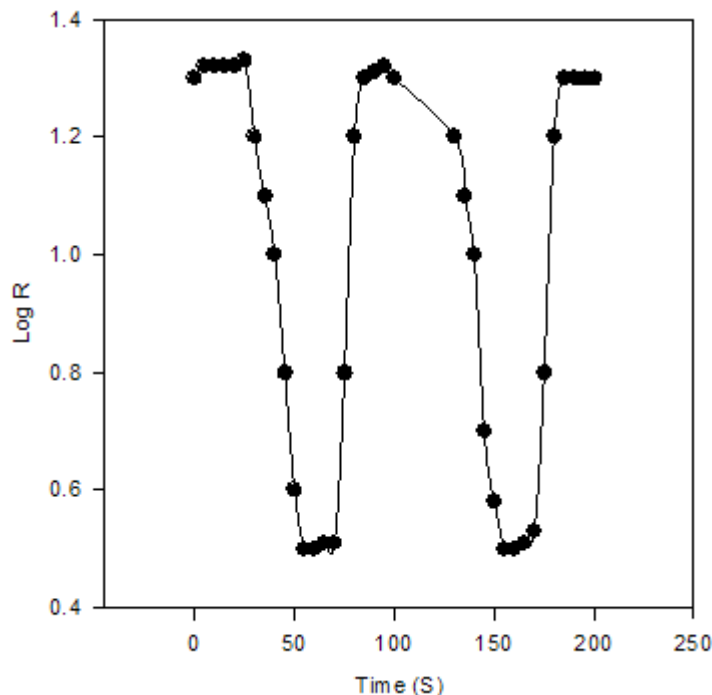


Fig. 4. Invariant resistance in 20000 ppm of hydrogen.

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References

- [1]. P. M. Ajayan, L. S. Schadler, C. Giannaris, A. Rubio, Single-walled carbon nanotube polymer composites, *Adv. Mater*, 12, 2000, pp. 750-753.
- [2]. R. Andrews, D. Jacques, A. M. Rao, T. Rantell, F. Derbyshire, Y. Chen, J. Chen & R. C. Haddon, Nanotube composite carbon fibers, *Appl. Phys. Lett*, 75, 1999, pp. 1329-1331.
- [3]. S. Iijima, Carbon nanotubes, *Nature*, 1991, pp. 354-356.
- [4]. H. H. Gommans, J. W. Alldredge, H. Tashiro, J. Park, J. Magnuson & A. G. Rinzler, *J. Appl. Phys.*, 88, 2000, pp. 2509-2514.
- [5]. R. Hagenmueller, H. H. Gommans, A. G. Rinzler, J. E. Fischer & K. I. Winey, Aligned single-wall carbon nanotubes in composites by melt processing methods, *Chem. Phys. Lett.* 2000, 330, pp. 219-225.
- [6]. Cabot, J. Arbiol, J. R. Morante, U. Weimar, N. Barsan, W. Gopel, Analysis of the noble metal catalytic additives introduced by impregnation of as obtained SnO₂ sol-gel nanocrystals for gas sensors, *Sensors and Actuators B*, 70, 2000, pp. 87-100.
- [7]. S. Shukla, L. Ludwig, C. Parrish, S. Seal, Inverse-catalyst-effect observed for nanocrystalline-doped tin oxide sensor at lower operating temperatures, *Sensors and Actuators B*, 104, 2005, pp. 223-231.
- [8]. L. R. B. Santos, T. Chartier, C. Pagnoux, J. F. Baumard, C. V. Santilli, S. H. Pulcinelli, A. Larbot, Tin oxide nanoparticle formation using a surface modifying agent, *Journal of the European Ceramic Society*, 24, 2004, pp. 3713-3721.
- [9]. F. Liu, B. Quan, L. Chen, L. Yu, Z. Liu, Investigation of SnO₂ nanopowders stored for different time and BaTiO₃ modification, *Materials Chemistry and Physics*, 87, 2004, pp. 297-300.
- [10]. J. Gong, Q. Chen, W. Fei, S. Seal, Micromachined nanocrystalline SnO₂ chemical gas sensors for electronic nose, *Sensors and Actuators B*, 102, 2004, pp. 117-125.

- [11].G. Tournier, C. Pijolat, R. Lalauze, B. Patissier, Selective detection of Co and CH₄ with gas sensors using SnO₂ doped with palladium, *Sensors and Actuators B*, 26-27, 1995, pp. 24-28.
- [12].A. Kazemzadeh, M. Valizadeh, H. Raisian, Transport phenomena on single walled carbon nanotubes, *Asian Journal of Chemistry*, 20, 5, 2008, pp. 3401-3407.
- [13].Xu, J. Tamaki, N. Miura, N. Yamazoe, Grain size effects on gas sensitivity of porous SnO₂ –based elements, *Sensors and Actuators B*, 3, 1991, pp. 147-155.
- [14].G. Zhang, M. Liu, Effect of particle size and doping on properties of SnO₂ – based gas sensors, *Sensors and Actuators B*, 69, 2000, pp. 144-152.
- [15].S. G. Ansari, P. Boroojerdian, S. R. Sainkar, R. N. Karekar, R. C. Aiyer, S. K. Kulkarni, Grain size effect on H₂ gas sensitivity of thick film resistor using SnO₂ nanoparticles, *Thin Solid Films*, 295, 1997, pp. 271-276.

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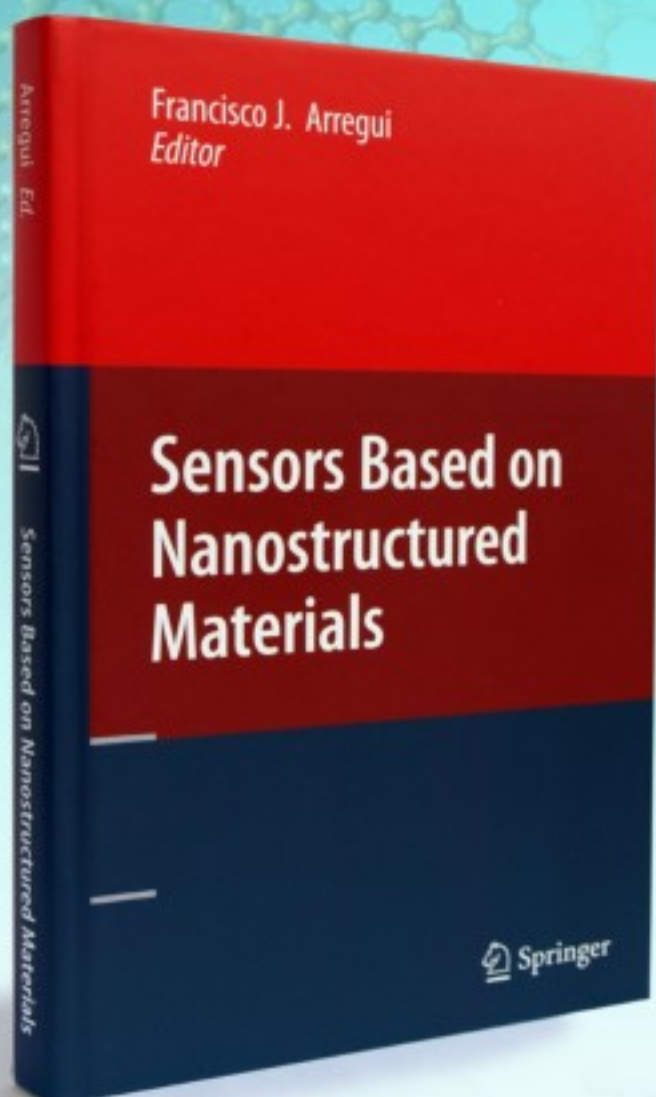
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