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Vertically Aligned Carbon Nanotubes on Carbon Fibers for Gas Sensor Applications

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Abstract – Vertically aligned carbon nanotubes have been processed by plasma-enhanced-chemical-vapor-deposition (PECVD) using Ni as catalyst deposited on carbon fibers. Acetylene (C_2H_2) was used as gas carbon source in a process assisted by plasma with ammonia (NH_3). Microscopy images show vertically oriented carbon nanotubes with dimensions as a function of reaction time, with a wide length distribution which is in the range 0.5-4μm. Besides, the coverage of carbon fibers with CNT also is influenced by this time. We expect to provide a contribution of this material for several applications, such as fuel cells, gas sensors and other new technologies.

Since the rediscovery of carbon nanotubes by Iijima [1], this material is one of the most promising for the development of new technologies, based on mechanical and electrical properties, such as gas sensors, field effect transistor, and other applications [2]. The goal of this work is an optimization of the carbon nanotubes (CNT) synthesis on carbon fibers (CF) for gas sensor and fuel cell applications. We obtained vertically aligned carbon nanotubes (VACNT) using DC plasma power supply in a chemical vapor deposition process. Initially, the CF was covered with a layer of catalyst Nickel (15nm) by resistive evaporation. Then, we heated the sample (CF), with previously deposited Ni (15nm), in a vacuum chamber at 160sccm ammonia flux. DC bias plasma is generated at about 530ºC with the acetylene flux (68sccm) introduced into the chamber to promote the reaction. The CNT grows vertically aligned due to the electric field generated by the plasma. The time dependence of the reaction changes the length and density of CNT on the fiber. Figure 1 shows the scanning electron microscopy (SEM) image of the CNTs grown on fibers during 30min (Fig. 1(a)), 40min (Fig. 1(b)) and 60min (Fig. 1(c)). The differences can be seen in the synthesis process on the basis of this analysis. Figure 1(a) shows partial coverage of fiber with VACNT of an average length estimated of 0.5μm. In Figure 1(b), the best results are observed, with the higher density and length of CNTs (3μm).On other hand, in Figure 1(c), the distribution of CNTs on fiber is worse and the tubes have a smaller length (2μm). An evaluation the time dependence of VACNT was presented by the analytical technique, SEM. These samples are expected to be used as gas sensors with a good sensibility and selectivity as well as in fuel cells. The better understanding of this material is essential towards their application in a variety of fields of materials science.

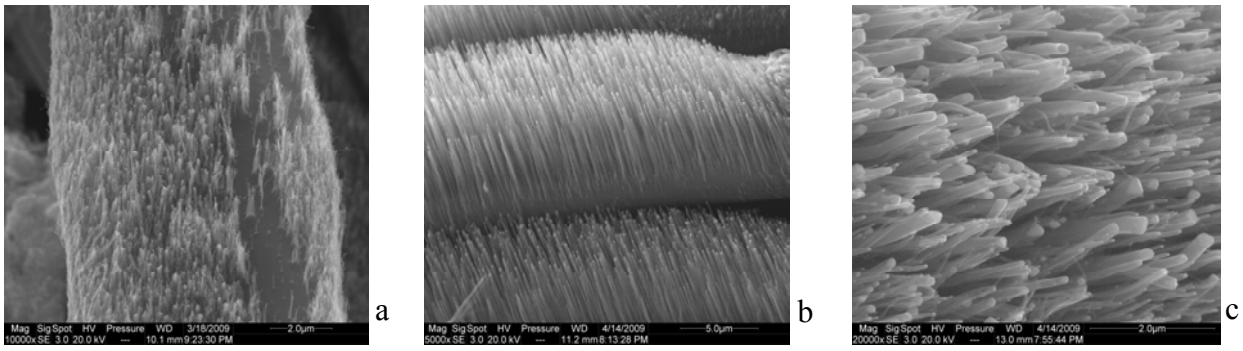

Figure 1: SEM image of carbon nanotubes grown on carbon fiber using different deposition times: (a) 30min, (b) 40min and (c) 60min

References

[1] S Iijima. Nature. 354 (1991) 56.
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