“Controlled size and localization of carbon nanotubes grown by catalytic CVD”

Emmanuelle Rouvière[a], Lucie Jodin[b], Anne-Claire Dupuis[c], Robert Baptist[b]

[a]CEA-Grenoble, LITEN/DTEN/STN,
[b]CEA-Grenoble, LETI/DIHS/LMNO,
[c]CEA-Grenoble, DRFMC/SP2M,
17 rue des Martyrs, 38054 Grenoble Cedex 9 (France)

The Basic Technological Research project “200mm Molecular Post-CMOS ” funded by the French Ministry for Research, aims at the development of electronics components based on nanomaterials or on single functional molecules. One of the investigated themes involves the manufacture of electronics devices using carbon nanotubes (CNTs) either in an active mode (diodes, transistors) or in a passive one (vias). More precisely, our goal is to make such devices using large (200mm) silicon wafers which can be processed in a clean room, either before nanotube deposition or after.

Within that framework, our objective is to control the localization and the diameter of CNTs grown on a silica substrate by Catalytic Chemical Vapor Deposition (CCVD). In this growth process, the CNT growth takes place on the catalytist nanoparticles previously deposited onto the substrate. The control over their localization thus implies a controlled localization of the grown CNTs. Besides, a direct dependence between the size of the nanoparticles and the diameter of the CNTs has been observed [1,2]. It is therefore essential to produce nanoparticles with monodispersed size distribution to homogeneously get CNTs with the desired diameter.

In this poster, we present our work on the catalyst nanoparticles in terms of their dispersion on a substrate and their dimensions. These iron and iron-molybdenum catalyst nanoparticles are obtained by thermal decomposition of carbonyl complexes [3]. This method allows us to control their size from 2 to 15 nm. The nanoparticles are dispersed on the substrate by spin-coating. Both size and dispersion are checked with AFM. Their composition and crystal structure are analyzed with TEM and XRD.

CCVD of CNTs is performed with CH_4 at around 950°C after a reduction process under H_2. The so grown CNTs are charcterized with SEM and TEM. A SEM image is shown on figure 1.

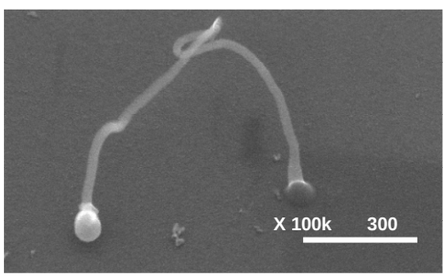

Fig. 1. SEM image of CNTs grown on Fe nanoparticles dispersed on a silica substrate

Finally, we are developing a nano-imprint method to obtain regular arrays of catalyst nanoparticles spaced out of 50 nm. Within the arrays, the nanoparticles are dispersed in PMMA, which is burnt off at 300-400 °C. After CNT growth, metallic electrodes will be deposited over the arrays of nanoparticles in order to perform transport measurements.

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