Conductivity of individual MWNTs used in composite fibres

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Due to their exceptional electrical, chemical, thermal and mechanical properties, carbon nanotubes are particularly appealing as building block of composite fibers, in particular to form light-weight conducting cables for electricity transport[1]. Long and robust fibers composed of carbon nanotubes embedded in a polymer matrix can notably be produced by coagulation techniques using CNT suspensions in PolyVinylAlcohol (PVA)[2,3]. In order to identify the effects of the intrinsic CNT characteristics on the final properties of macroscopic fibres, we studied in details the conductivity of individual CNTs as a function of length, diameter and synthesis parameters. Vertically aligned CNTs were first grown by CVD[4] and then detached from the growth substrate to form stable dispersions of CNTs with length of several µm. The same CNTs were used to prepare composite fibers and for electrical evaluation of the conductivity of individual CNTs (Fig. 1). In particular, a large number of individual CNTs were connected by palladium electrodes using e-beam lithography and their conductivity was assessed in different conditions to obtain statistically robust results. By considering several sections of the same nanotubes (with different length) and/or by comparing measurements at both low and high electric field, the impact of metal/CNT contact resistance was determined and the intrinsic CNT conductivity was evaluated. We notably obtained CNT conductivity in the 2.10^5 - 6.10^5 S/m range depending on the Length/Diameter ratio (using CNT with diameter in the 20-65 nm range). For nanotubes whose crystalline structure had been improved by post annealing treatment at 2000°C under Ar, a limited twofold increase in conductivity was observed compared with the raw CNTs. This highlights the good structural quality of the raw nanotubes synthesized in our laboratory. We compared the obtained conductivities with literature data which confirms the competitive quality of our synthesis and dispersion processes.

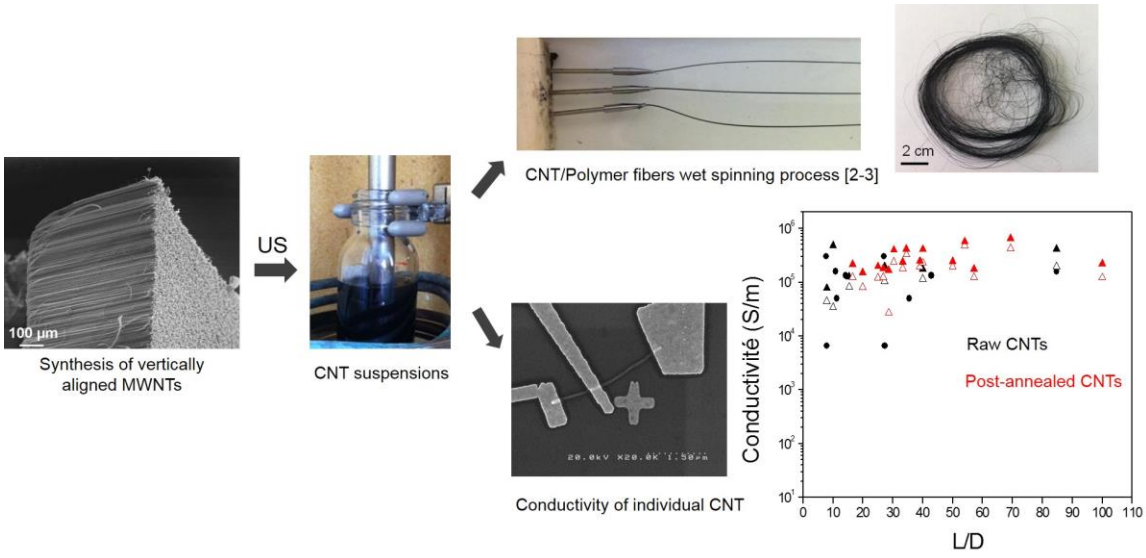

Figure 1: elaboration of CNT-based composite carbon fibers and measurements of electrical properties of individual CNT

This work is done in a consortium of several partners (RTE, CEA, CRPP, IMN, VUB). RTE as the French electricity transmission system operator is interested in fibers.

References

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