# Determination of geometrical length of airborne carbon nanotubes by filtration method

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The geometrical length of carbon nanotubes (CNTs) is of significant importance and this study aims at its fast determination. We evaluated a method to determine the geometrical length of CNTs by electrical mobility classification (Kim et al. 2007) and developed the filtration based method. The measurement was carried out in air and the suitable generation method for airborne CNTs from liquid suspensions was investigated, followed by a proper control of the CNT dispersion degree by changing the CNT concentration in the liquid suspension. Airborne CNTs were generated by an atomizer, classified by a differential mobility analyzer (DMA) and characterized by electron microscopy. The CNT geometrical lengths measured by electron microscopy served as the basis for comparison with the other methods. Two theoretical models (Lall and Friedlander, 2006 and Li et al., 2012) for elongated particles were investigated and the comparison showed good agreement. This provided an approach to determine the CNT length by the combination of mobility measurement and model calculation. The other developed method, which employed a filtration model with uniform screens, showed comparable results with the CNT lengths as obtained from the electron microscopy.

Figure 1 shows a schematic of CNT filtration measurement system, which consists of an airborne CNT generation system, a size classification system and penetration measurement system. A Collison type atomizer was used to generate airborne CNTs. The multi walled carbon nanotubes (MWCNTs) from the generator were passed through a diffusion dryer to ensure that liquid vapors were removed. In order to classify the generated airborne CNTs, a DMA (TSI 3081) was used. The mobility size distribution was obtained by using the scanning mobility particle sizer (SMPS). In order to control the degree of CNT dispersion, the concentration of CNTs in the suspensions was varied and the resulting size distributions of aerosolized CNTs were measured.

Single dispersed airborne CNTs were collected on silicon substrates, by using a nanometer aerosol sampler (TSI 3089), for SEM analysis sample preparation purposes. A large number of DMA-classified airborne MWCNTs were collected and their lengths were measured from the SEM images. The length distribution of MWCNTs was fitted to a lognormal distribution and mean lengths of MWCNTs were obtained. The obtained geometrical lengths were compared with models provided by Li et al. (2012) and Lall and Friedlander (2006). The lengths were also compared with calculated lengths by the filtration method, which included the particle capture mechanisms (Wang et al. 2011a, b). The results are shown in Figure 2 and comparison with our SEM results showed that the models give satisfactory results.

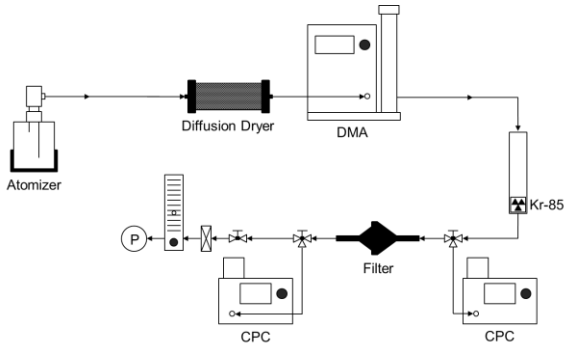


Figure 1. Experimental system for CNT filtration tests.

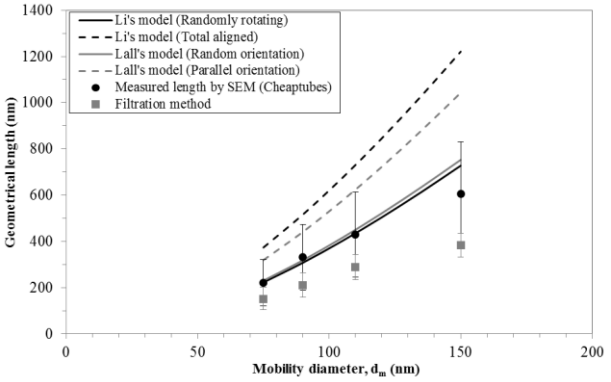


Figure 2. Comparison between the measured geometrical length of CNTs by SEM analysis and obtained length of CNTs by model calculations.

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