Estimation of the stiffness parameters of a nanofibre forest

Koissin V.*, Warnet L., Akkerman R.

Univ. of Twente, Chair of Production Tech., 7500AE, Enschede, The Netherlands
**e-mail: v.koysin@ctw.utwente.nl*

Growth of nanotubes or nanofibres (CNFs) on the carbon-fibre fabrics is a way to improve the fibre-matrix interface and crack bridging and, consequently, the damage resistance of the fibre-reinforced composites [1]. On the other hand, the fabric deformability is foreseen to be altered by numerous inter-fibre links. To model these effects analytically or using an FE analysis, it is necessary to know the mechanical properties of a single nanoparticle. However this is not easy due to a tiny size of the objects. There are only few published studies on this point, [2], and all of them utilize a complex test equipment and are time-consuming.

Moreover, the nanoparticles can have very randomized shapes and diameters, as illustrated in Fig.1. Thus, even if 10-20 single CNFs are tested in bending or tension to produce a representative sample, it can be very problematic to derive the Young's modulus using the elastic beam or strut model [2].

The present study aims to explore a more practical way to estimate the stiffness "on average". This is attempted using relatively simple test methods: 1) out-of-plane compression of a fabric, 2) compression of the yarns extracted from the fabric, and 3) compression of a large volume of loose CNFs.

Experimental part of the study focuses on a particular case of a carbon-fibre fabric grafted with in-situ grown CNFs (using the Chemical Vapour Deposition technique). For comparison, the virgin fabric (without CNFs) is tested also.

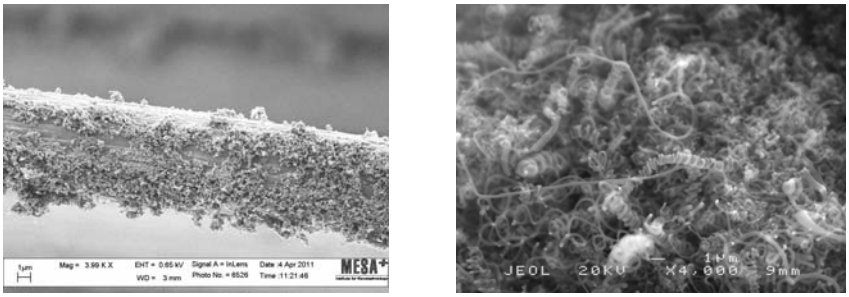

Figure 1. Carbon fibre with grown CNFs (left) and closer view of the CNF "forest" (right).

[1] Koissin V., Warnet L., Akkerman R., Proc. of 14th Int. Conference on Experimental Mechanics, Poitiers, France (2010).

[2] Demczyk B.G., Wang Y.M., Cumings J., Hetman M., Han W., Zettl A., Ritchie R.O., *Materials Science and Engineering A* **334**, 173 (2002).