MICROSTRUCTURAL AND MECHANICAL CHARACTERIZATION OF YARNS MADE FROM CARBON NANOTUBES FOR THE INSTRUMENTATION OF PARTICLE BEAMS AT CERN

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Existing copper-coated carbon fibers used in wire scanners to measure the transverse beam profile in the accelerators at CERN are approaching material limits. A new instrument design has showed that the main limitation now comes from the centerpiece of the instrument: the wire. Large amplitude vibrations increase the risk of failure during scans. New required specifications concerning the beam measurements for the Future Circular Collider (FCC) project cannot be met. Fortunately, the commercial development of long microscopic yarns made of spun carbon nanotubes has paved the way for possible alternatives. The objective of this study is to determine if those Carbon NanoTube Yarns (CNTY) could replace the current carbon fibers (CF) for beam instrumentation, and if so, to determine the best configuration in terms of diameters and mounting system. To do so, we have made extensive testing and microscopy on CNT yarns with diameters of 10, 20 and 30 µm, with two different mounting systems, the Paper Frame conditioning (PF) or partial Copper-Coated conditioning (CC). A Weibull approach was used to extrapolate our results to the real length of the wires used in operational instruments. This study shows that considering the Weibull criteria, the best configuration to increase the accuracy of the beam profile measurement is to use a not copper-coated 20-µm diameter CNTY.

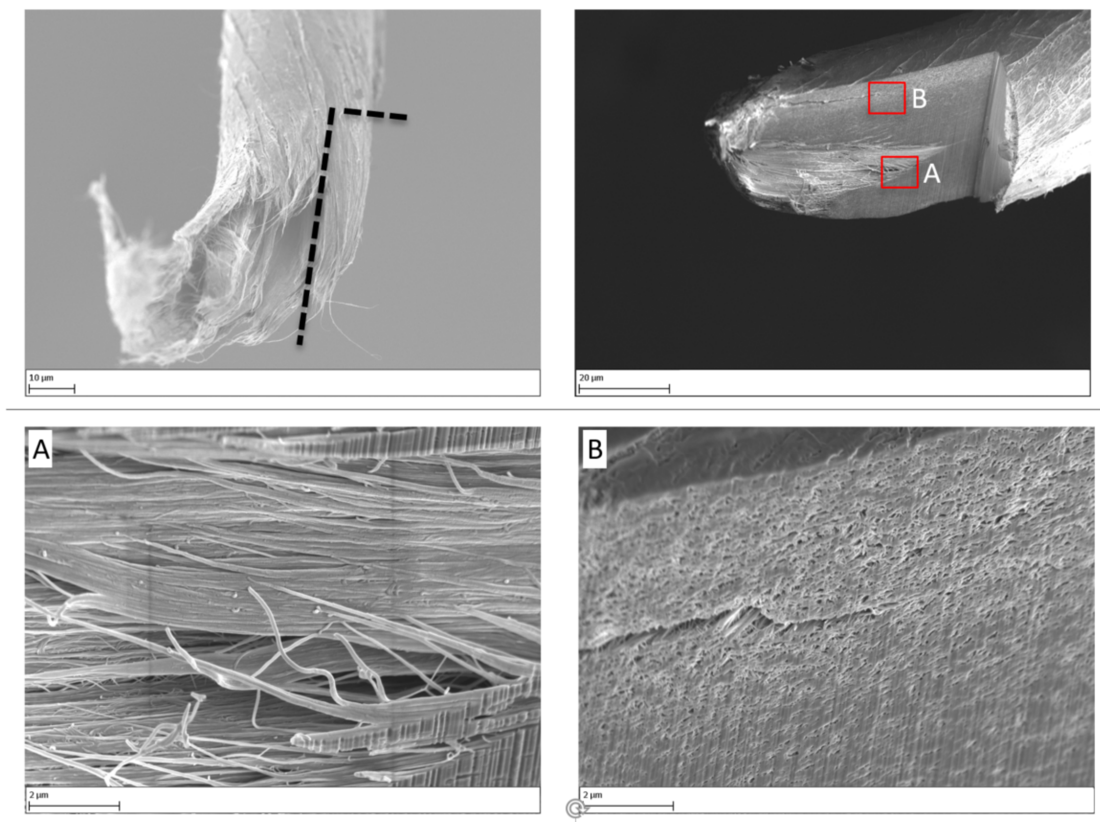

Figure 1 – Representative images of the cross section at the fracture area after tensile test prepared by Focused Ion Beam-Scanning Electron Microscopy (FIB-SEM) in Sample A