

Supporting Online Material

I. Details of the Draw-Twist Process

Although we have very recently automated the simultaneous draw-twist spinning process, the results described in the paper were achieved using motor-assisted hand-drawing of the yarn. The yarn was started by pulling MWNTs from a side of a nanotube forest using a cylindrical wood tooth pick, and hand wrapping this yarn on the tooth pick. The larger the forest sidewall area used for this initial draw, the larger the diameter of the resulting twisted yarn. The tooth pick was attached as a spindle on the shaft of a motor, which was mounted on a platform that was free to slide on a table top (see Fig. S1). The draw-twist process was accomplished by sliding the motor platform along the table top and away from the nanotube forest to accomplish yarn draw, while the motor was operated at approximately 2000 rpm to provide yarn twist. In order to make this ribbon clearly visible in the photograph, a very large wedge-shaped ribbon was used for the spinning shown in Fig. S1. The choice of such a large wedge (3.5 mm in greatest width) results in a yarn whose diameter is so large, compared to the presently used 300 μm or shorter MWNT length, that the lateral forces needed for yarn strength do not effectively develop. Fig. S2 complements the SEM images of Fig. 1 and Fig. 2A by providing an additional view and showing the relationship between images.

II. Mechanical Property Measurements

Since the MWNT yarns had diameters down to a micron (corresponding to a cross-sectional area up to a thousand times smaller than for conventional yarns), mounting these nearly invisible yarns for mechanical tests was quite challenging. For ease of handling and to prevent possible loss of twist, the yarn was glued (using 5 wt. % PVA solution) across a centimeter size square hole in the center of a 15 mm wide paper frame. After this paper frame containing the MWNT yarn was mounted in the tensile test apparatus (Instron 5848 microtester, Instron Corp., Canton, MA), opposite sides of the paper frame were cut to free the yarn. The yarn gauge length was 1 cm, which is about 50 times the MWNT length. The tensile tests were conducted at a constant rate of extension of 1% per minute. For converting the applied force to the engineering stress, the diameter of the yarn sample was measured using an SEM.

The Poisson ratio measurements were conducted inside a SEM using a Zyvex S100 Nanomanipulator (Zyvex Corporation, Richardson, TX), which enabled measurement of lateral yarn dimension as a function of yarn elongation during loading and unloading.

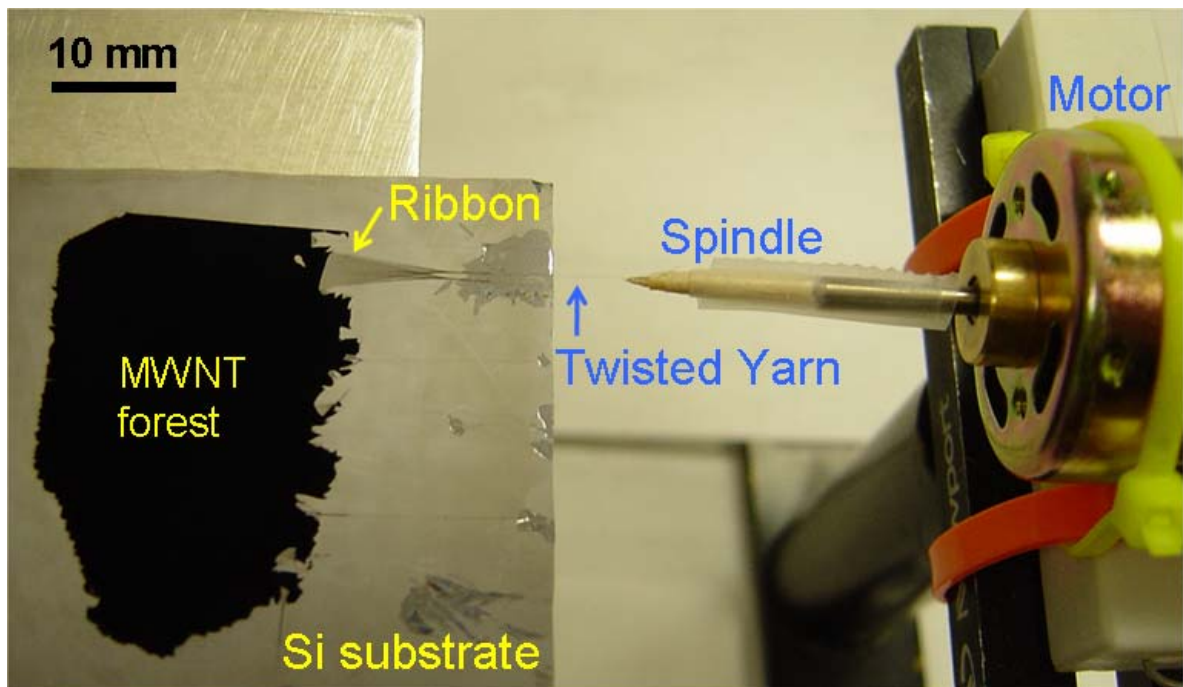


Fig. S1. Photograph taken during interruption of the draw-twist process used to convert MWNTs in a forest to a twisted MWNT yarn. The overlapping images of both the nanotube wedge and yarn are a result of reflection in the silicon substrate.

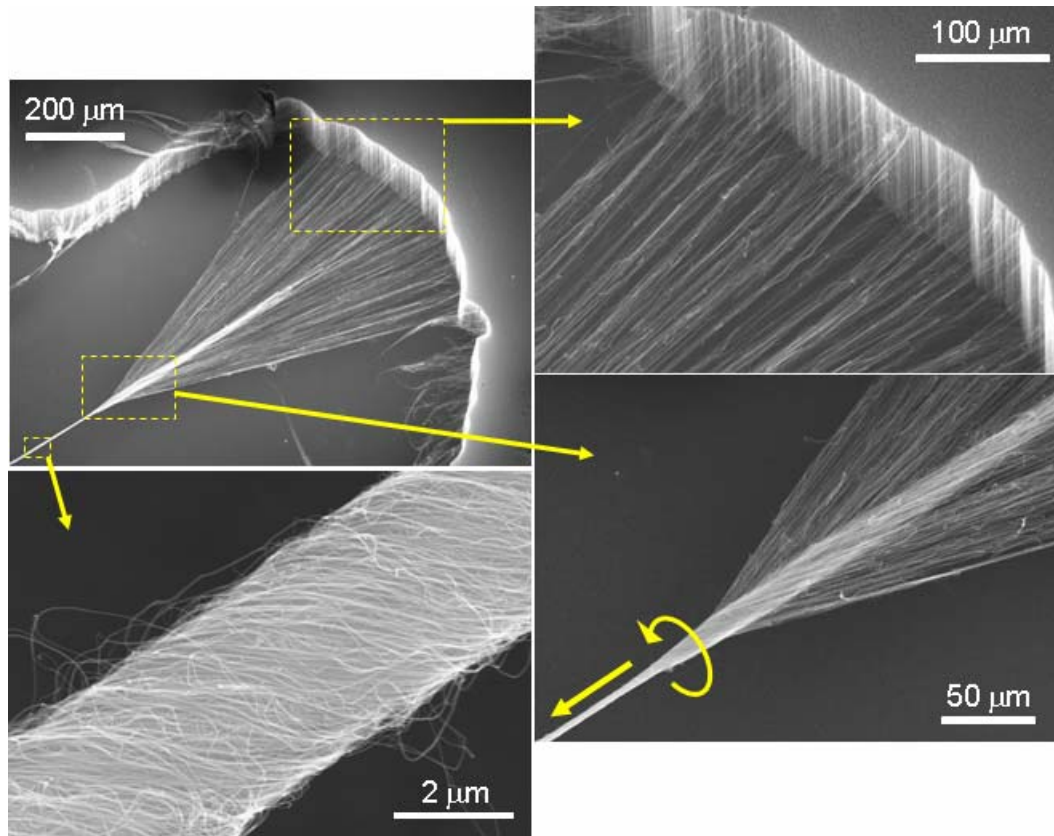


Fig. S2. SEM micrographs showing the structures formed during the draw-twist process. The relationships between the SEM micrographs of Fig. 1 and Fig. 2A are shown, as well as a higher magnification image of the partially bundled MWNTs being pulled from the forest wall. The draw twist process was interrupted, and the sample was transferred to a SEM for recording these images.