A carbon nanoribbon is formed when a carbon nanotube flattens in one direction. We have found that a switching in the flattening direction results in the formation of a carbon nanotetrahedron in the middle of a carbon nanoribbon [1] (Fig. 1). Our TEM and SEM observations suggest a model of its formation mechanism as follows. When a carbon nanotube is expelled from an Fe catalyst nanoparticle, the tube is forced to flatten, and there are two preferable directions of flattening, which we call the origami mechanism. When one direction is dominant, a nanoribbon is formed, while a nanotetrahedron is formed when a switching of the flattening direction occurs (see Ref. 1 for more details).

To reveal bending properties of our carbon nanotetrahedron/nanoribbon structures, they were examined using a micromanipulator in a TEM and their bending behavior was observed in-situ [2]. We have found that a nanotetrahedron/nanoribbon structure bent at a nanotetrahedron/nanoribbon junction, and that the bending was reversible and repeatable. The nanotetrahedron/nanoribbon structures kept their shape during being bent and did not expand to take a tubular form. Our results show that the nanotetrahedron/nanoribbon structures have excellent durability against bending. The nanotetrahedron/nanoribbon structures can be bent at nanotetrahedron/nanoribbon junctions sharply and do not break, therefore we expect that the nanotetrahedron/nanoribbon structures can be used for three-dimensional wiring.


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Fig. 1: TEM images and schematic illustration of carbon nanotetrahedron/nanoribbon structures (from Ref. 1).