CLAIMS

1. A sensor, comprising:

a composite substrate comprising a template material comprising a plurality of insulating fibers and a plurality of carbon nanotubes bonded to the insulating fibers forming a nanotube coating on the insulating fibers, the composite substrate having a fracture induced by application of a unidirectional tensile force to the composite substrate, wherein the plurality of insulating fibers forms a plurality of crossbar junctions at the site of the fracture; and

a first electrode coupled to the nanotube coating on one side of the fracture and a second electrode coupled to the nanotube coating on the opposite side of the fracture, such that an electrical signal applied between the first electrode and the second electrode passes through the plurality of crossbar junctions at the site of the fracture.

2. The sensor of Claim 1, wherein the carbon nanotubes are multi-wall carbon nanotubes.

3. The sensor of Claim 1, wherein the insulating fibers are fibers extracted from wood pulp, cotton fibers, synthetic fiber, or a combination thereof.

4. The sensor of Claim 1, wherein the insulating fibers are carbohydrate fibers.

5. The sensor of Claim 4, wherein the carbohydrate fibers are cellulose fibers.

6. The sensor of Claim 1, wherein the template material has a thickness in the range of 0.1 microns to 10,000 microns.

7. The sensor of Claim 1, wherein the template material is a cellulose fiber matrix.

8. The sensor of Claim 1, wherein the sensor is an in-plane strain sensor, an out-of-plane piezo-resistive sensor, or a capacitive sensor.

9. The sensor of Claim 1, wherein the sensor types are determined by an applied strain.

10. The sensor of Claim 1, wherein the carbon nanotubes have a diameter in the range of 0.8 nm to 200 nm.

11. The sensor of Claim 1, wherein carbon nanotubes have a length between 0.1 μm and 100 μm.

12. The sensor of Claim 1, wherein the insulating fibers have a diameter between 10 nm and 100 μm.

13. The sensor of Claim 1, wherein the insulating fibers have a curvature radius larger than 10 μm.

14. The sensor of Claim 1, wherein carbon nanotubes are bound to the insulating fibers by hydrogen bonding, ionic bonding, covalent bonding, nonspecific bonding, or a combination thereof.

15. The sensor of Claim 1, wherein the first electrode and the second electrode are prepared from electrically conductive epoxy.

16. The sensor of Claim 1, wherein the first electrode and the second electrode are silver.

17. The sensor of Claim 1, wherein the sensor is configured for use to monitor human behavior.

18. The sensor of Claim 1, wherein the sensor is a heartbeat sensor, gripping motion sensor, finger movement sensor, eye movement sensor, mouth movement sensor, or abdominal movement sensor.

19. The sensor of Claim 1, wherein the sensor is a wearable sensor.

20. The sensor of Claim 1, wherein the sensor is a disposable.

21. The sensor of Claim 1, wherein the sensor comprises a substrate material attached to the composite substrate.

22. The sensor of Claim 21, wherein the substrate material is paper.

23. The sensor of Claim 21, wherein the substrate material is attached using tape, glue, infiltrating polymer, filler material, or a combination thereof.

24. A method of making a sensor comprising applying a unidirectional tensile force to a precursor composite substrate thereby inducing a fracture to form a fractured composite substrate, wherein the precursor composite substrate comprises:

a template material comprising a plurality of insulating fibers;

a plurality of carbon nanotubes bonded to the insulating fibers forming a nanotube coating on the insulating fibers;

a first electrode coupled to the nanotube coating on one side of the fracture; and

a second electrode coupled to the nanotube coating on the opposite side of the fracture; and

wherein the plurality of insulating fibers form a plurality of crossbar junctions at the site of the fracture.

25. The method of Claim 24, wherein the carbon nanotubes are multi-wall carbon nanotubes.

26. The method of Claim 24, wherein the method further comprises attaching the fractured composite substrate to a substrate material.

27. The method of Claim 24, wherein the method further comprises folding or rolling or wrapping the fractured composite substrate to reduce the size.

28. The method of Claim 24, wherein precursor composite substrate is formed by applying a composition comprising multi-wall carbon nanotubes to the template material by capillary action.

29. The method of Claim 28, wherein the composition comprising carbon nanotubes is an aqueous suspension of carbon nanotubes.

30. The method of Claim 29, wherein the aqueous suspension of carbon nanotubes further comprises a surfactant.

31. The method of Claim 28, wherein the applying a composition comprising carbon nanotubes is repeated at least 3, at least 10, or at least 20 times.

32. The method of Claim 28, wherein the applying a composition comprising carbon nanotubes to the template material is followed by applying the first electrode and the second electrode.

33. A sensor manufactured by the method of Claim 24.