Beautiful diamond jewels, graphite used in pencil leads, soccer ball-shaped C_{60}, fullerenes, and carbon nanotubes (CNTs); they all consist of single element, carbon. Because CNTs have a fine straw shape with a diameter of less than one ten-thousandth of a millimeter and is light and strong, these novel properties make them potentially useful for a variety of applications in fields, such as nanowiring for future LSIs, and transparent electrodes. However, depending on the “handedness,” or chirality, of CNTs, its properties differ greatly, for example, showing metal-like conductivity or the properties of a semiconductor. To date, attempts to control the chirality have not been successful.

In order to use CNTs for nanowiring and similar applications, high electrical conductivity independent of chirality is necessary. We have successfully fabricated boron-doped CNTs by a simple chemical vapor deposition method employing an electric furnace. Using electron beam lithography, four terminals were fabricated on a CNT and its electrical conductivity was measured (see Fig. 1). The results showed that the electrical conductivity of the CNTs at room temperature is one to two orders of magnitude higher than that of conventional multi-walled CNTs. Furthermore, it was also found that the CNTs retain its high electrical conductivity at down to extremely low temperatures (see Fig. 2).

Our group is conducting research on high electric conductivity and superconductivity that are found to occur when boron is added to diamond. Similarly, in CNTs, we assume that hole carriers are introduced into carbon when doped with boron, making it possible to obtain high electrical conductivity independent of the chirality of CNTs. In the future, superconductivity could also be found in boron-doped CNTs.

This new method has applications in a wide range of fields, including transparent electrodes and conductive films produced by adding CNTs to resins, nanowiring for future LSIs, CNT field effect transistors (FET), probes for scanning probe microscopes, electron emission devices, and fuel cells.

Titanium oxide photocatalysts are applied as environmental purification materials in a variety of products. In actuality, a titanium oxide photocatalyst is usually coated on the surface of a substrate of ceramic, glass, metal, or other materials in the purification devices for decomposition of harmful substances in the air.

In conventional titanium oxide photocatalytic filters, a slurry (a liquid dispersed with titanium oxide) mixed with a silica-based binder (a component which fixes the titanium oxide on the substrate surface) is coated on a porous ceramic material and fixed by heat treatment. However, for various reasons, the films produced by this process did not possess adequate photocatalytic activity. For example, in addition to the fact that a sufficient reaction surface area was not secured, light failed to reach the film interior, and the film contained heterogeneous silica compounds.

To solve these problems, we conducted a joint research on the development of new photocatalyst-coated films with Meidensha Corporation. First, we produced the films on glass, and their performance was characterized (Fig. 1). The results showed that the electrical conductivity of the CNTs at room temperature is one to two orders of magnitude higher than that of conventional multi-walled CNTs. Furthermore, it was also found that the CNTs retain its high electrical conductivity at down to extremely low temperatures (see Fig. 2).

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