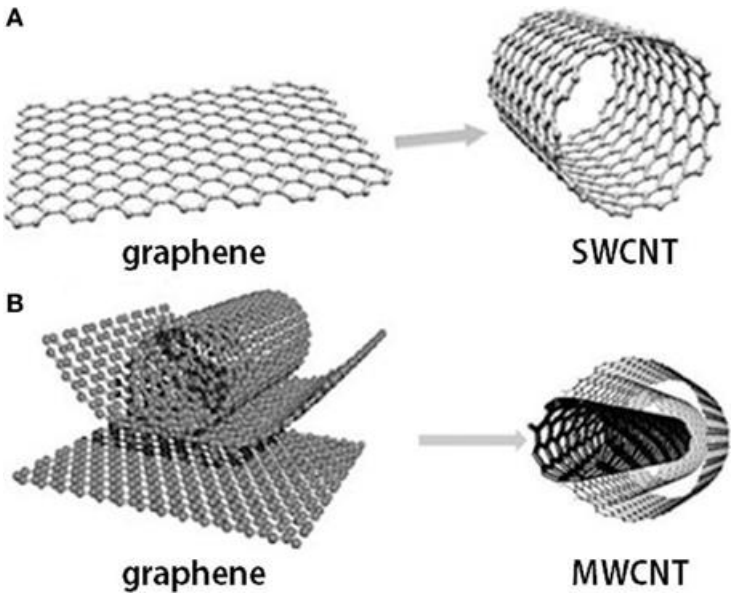
## Carbon nanotubes (CNTs)

Carbon nanotubes (CNTs) are a class of nanomaterials that have gained immense attention and recognition since their discovery in 1991 by Sumio Iijima. They are cylindrical structures made of carbon atoms arranged in a hexagonal lattice, similar to graphene, but rolled into seamless tubes.

**Structure:** Carbon nanotubes can be thought of as rolled-up sheets of graphene, where the carbon atoms are arranged in a honeycomb pattern. This cylindrical structure can be open-ended (resembling a straw) or closed at both ends (similar to a rolled-up piece of paper). CNTs can be either single-walled (SWCNTs) or multi-walled (MWCNTs), with SWCNTs consisting of a single graphene layer and MWCNTs containing multiple concentric layers.




**Properties:** Carbon nanotubes possess a wide range of remarkable properties, including:

- **Exceptional Strength:** CNTs are incredibly strong and are among the strongest materials known, with high tensile strength.
- **Lightweight:** They are exceptionally lightweight, offering advantages in weight reduction for various applications.
- **Electrical Conductivity:** SWCNTs can be either metallic or semiconducting, making them excellent conductors for electronics and sensors.
- **Thermal Conductivity:** CNTs are outstanding thermal conductors and can efficiently dissipate heat, making them valuable in thermal management.
- **Large Surface Area:** CNTs have a large surface area, making them suitable for adsorption and catalysis applications.

- **Chemical Stability:** They are chemically stable and can resist many harsh environments.

**Applications:** Carbon nanotubes have a wide range of applications due to their exceptional properties:

1. **Nanocomposites:** CNTs are used to reinforce and enhance the mechanical, electrical, and thermal properties of materials such as polymers, ceramics, and metals. These nanocomposites are used in aerospace, automotive, and construction industries.
2. **Electronics:** SWCNTs can be used in transistors, interconnects, and sensors. They have the potential to create faster and more efficient electronic devices.
3. **Energy Storage:** CNTs are used in supercapacitors and batteries, where their high surface area and electrical conductivity can improve energy storage and delivery.
4. **Thermal Management:** CNTs are excellent thermal conductors and are used in thermal interface materials to dissipate heat in electronics and high-performance systems.
5. **Sensors:** CNTs are sensitive to various gases, making them suitable for gas sensors. They are also used in biosensors for detecting biomolecules.
6. **Aerospace:** Their lightweight, strong, and conductive properties make CNTs suitable for aerospace applications, including aircraft and spacecraft components.
7. **Medical Applications:** Carbon nanotubes are explored for drug delivery systems, tissue engineering, and as contrast agents in medical imaging.
8. **Water Purification:** CNTs can be used in water purification to remove pollutants and heavy metals.
9. **Nanoelectromechanical Systems (NEMS):** CNTs are used in NEMS for various applications, such as resonators and switches.
10. **Coatings:** CNTs are used in anti-static coatings, anti-corrosion coatings, and as conductive coatings in touch screens and displays.