Superconductivity at Room Temperature

Scientists of Institute of Science (IISc), have confirmed superconductivity at room temperature.

- Till now, scientists have been able to make materials superconductor only at temperatures much below 0°C and hence making practical utility very difficult.
- The material used in this research is nanosized films and pellets made of silver nanoparticles embedded in a gold matrix.
    - Two of the most important properties of superconductivity are diamagnetism and zero resistance. It suggests that the material becomes superconducting below a certain temperature (286 K or 13°C). and it can go up to 70°C.
    - There is a clear transition from a normal state to a superconducting state at 286 K
    - Interestingly, silver and gold independently do not exhibit superconductivity.

Controversies

- The scientists from Tata Institute of Fundamental Research (TIFR) Mumbai have raised concerns that while the drop in mutual inductance is fairly sharp, it is at a lower temperature compared with resistance.
- In superconductivity when the resistance goes to zero the diamagnetic drop should coincide with resistance drop. Here the resistance drops to zero at 175 K but the diamagnetic drop is at 165 K. This kind of difference between resistance and diamagnetic drop is unusual.

Superconductor

- Superconductors are materials that conduct electricity with no resistance. Unlike the more familiar conductors such as copper or steel, a superconductor can carry a current indefinitely without losing any energy. They also have several other very important properties, such as the fact that no magnetic field can exist within a superconductor.

- Another property of a superconductor is that it will exclude magnetic fields, a phenomenon called the Meissner effect.
- The disappearance of electrical resistivity was modelled in terms of electron pairing in the crystal lattice by John Bardeen, Leon Cooper, and Robert Schrieffer in what is commonly called the BCS theory.
- Advantage of superconductors:
    - Currently, superconductivity can only be achieved at temperatures far below zero, in processes that are too expensive for wider application.
    - The devices have low power dissipation, high operating speed, and extreme sensitivity.
    - Devices built with room temperature superconductors tend to be extremely efficient and entail large savings in both energy and costs.
- Application: Superconductors already have drastically changed the world of medicine with the advent of MRI machines, which have meant a reduction in exploratory surgery.

    Power utilities, electronics companies, the military, transportation, and theoretical physics have all benefited strongly from the discovery of these materials.

Meissner effect

When a material makes the transition from the normal to the superconducting state, it actively excludes magnetic fields from its interior; this is called the Meissner effect. This constraint to zero magnetic fields inside a superconductor is distinct from the perfect diamagnetism which would arise from its zero electrical resistance.

Critical temperature

- The **critical temperature** for superconductors is the temperature at which the electrical resistivity of metal drops to zero.
- The transition is so sudden and complete that it appears to be a transition to a different phase of matter; this superconducting phase is described by the BCS theory.

Diamagnetism

Diamagnetism is a very weak form of magnetism that is induced by a change in the orbital motion of electrons due to an applied magnetic field. This magnetism is nonpermanent and persists only in the presence of an external field. The magnitude of the induced magnetic moment is very small, and its direction is opposite to that of the applied field.