

Solar Power: a Brief Summary

The sun emits electromagnetic spectrum energy from infrared to ultraviolet light. Photons, the basic particle of electromagnetic force, are spin particles, so electromagnetic force is intrinsically handed in three dimensions, therefore altering the path of particles at any angle not parallel with it.

Therefore transverse waves can transmit across the vacuum between the sun and earth, conserving its frequency. This energy is absorbed by an electrically charged particle which emits an electron, producing a potential difference. Semiconductors absorb the energy increasing with either bound (excitons) or separate hole-electron pairs.

Semiconductors are characterised by change in resistance under temperature, because unlike conductors, not only moving electrons but also moving valence shell spaces carry charge, so moving charge is not only negative but also positive. This arises when electrons escape bonds through energy absorption. Silicon and germanium atoms' outer shells can hold eight electrons but contain only four, so these four form covalent bonds, occupying the outer shells of two atoms each. This arranges them into a square grid, each atom having an electron 'on four sides'. When heat is absorbed, some electrons gain enough energy to break these bonds, leaving a positively-charged bound ion. This positive charge in the electron shell can attract free or neighbouring electrons, in turn leaving behind an empty valence shell space. These effectively mobile positive charges are called 'holes'.

Efficiency capacity factor = actual production/maximum production. Reducing reflectance, focussing more light onto cells and cells able to absorb energy from multiple wavelengths increase efficiency. Multijunction cells are made of layers of semiconductors excited at decreasing frequencies, each layer absorbing higher energy photons but transmitting lower energy ones to lower layers, with a “tunnel diode” enabling electron transmission.

Organic photovoltaics addresses toxicity problems. Carbon-based chemical structures have low relative permittivity, so doping or charge carriers donated by electrodes are needed to make them semiconducting. Instead of a bandgap between layers in crystalline semiconductors, the energy difference between the highest (HOMO) and lowest (LUMO) molecular orbitals absorbs and emits solar energy. Changing the electron orbitals in carbon molecules ('conjugation') makes the band gap small enough for visible light to excite electrons from HOMO to LUMO.