Nano-Electronics with Particular Reference to Medical Applications

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Physical properties of nanometric particles are surprisingly different from volume effects, particularly regarding the semiconducting materials. Organic materials form a very impressive range of nanometric applications, especially in such fields as medicine.

An outstanding example is the creation of a blood substitute as pioneered by Prof. Thomas Chang at McGill University in Canada.

Polymer-biomolecule hybrids are suited for a number of potential nanomedicine applications. Polyhemoglobin cells are used as artificial cells. They are employed successfully for trauma surgery already. No side effects have been reported so far. They stay in circulation up to 27 hours and transfer oxygen and carbon-dioxide.

Similarly, the delivery of drugs and other medical tasks are possible.

Nanometric electronics is based on semiconducting materials. The concepts of analogue circuitry will typically have input signals from sensors, leading to amplified output for sending antennas. The required bias supply by batteries is difficult so that energy transfer is considered by optics or microwaves.

More advanced possibilities are then digital signal processing.

Sensors are provided to measure any data of interest. Antennas are introduced to transfer data to the outside. Piezo-Nano-Electromagnetic Systems (NEMS) are used for motion.

All these details are to be introduced on surfaces of the order of size of a few micrometers so that the conductor lines are typically around 5o nanometers in size, a dimension now used for ultrahigh IC-packaging.

Identification of chemical compositions is possible by Terahertz sensing.

Fluid flow measurement and control are performed by other suitable sensing approaches. Also, the identification of bacterial structures is attempted at the present time. Research is performed on living tissues. Also the supply of medicaments is envisaged to specific parts of the body. The transfer of material into living cells is attempted by adhesion of suitable molecules. In particular, some promising ideas are considered to perform in similar ways suitable material transfers in view of cancer treatment.

In the future, it can be envisaged that these nanometric units can be made to interact with each other via electromagnetic signals, received at inputs and emitted at their outputs.

This then gives entire systems mutually interacting for sensing, delivery, activating etc in particular environments such as biological bodies. Such intelligent nano-environments will be relevant for both small dimensions such as blood transporting vessels as well as for climatic applications in rooms or cavities.

It is envisaged to have these as part of clothing for medical applications or for severe thermal operation of workers in extreme winter conditions. Of course these possibilities are of particular interest for military applications.