Nanoscience and electronics work toward understanding material properties at the nanoscale. They aid in improving fabrication process technology to satisfy increasingly stringent dimensional tolerances and also look for other alternative cost-effective techniques.

The ICT (information and communication technologies) sector has primarily driven the progress of nanoscience. The first references to nanotechnology were in the use of ultra-thin layers, which were of relevance to the then-upcoming semiconductor industry. The electronics segment is likely to remain silicon-based in the foreseeable future due to historical and economic reasons. Current fabrication methods, however, can be termed as being on the nanoscale. The 130 nm technology used to manufacture the Intel Xeon processor defines the size of the DRAM half-pitch (half the distance between the adjacent metal wires in a memory cell).

A significant push towards adopting nanotechnology in the electronics segment is the requirement of a 22-nanometer fabrication technology to manufacture processors. This manufacturing requirement is associated with challenges such as new low dielectric materials, higher conductivity interconnects. Other problems also include developing tools that can fabricate in the sub-50 nanometer range and integrating advanced metrology tools in the manufacturing process. These tools are capable of sizing-down defects to the nanometer scale.

Data storage is another upcoming application area which, today, is mainly magnetic disk-based. Though memory density will continue to increase, the trend will be to replace disk-based devices with solid-state memory. However, for high-volume data storage, hard-drives (magnetic and optical) will continue to dominate. The area of using solid-state memory devices for information storage is an active area of nanoscience research.

Photonic crystals fabricated either through a lithographic process or through self-assembly techniques can confine and direct light in precise ways. This precision allows for transmission and functionality in a single structure. A typical photonic crystal would consist of an array of holes in a dielectric material fabricates with sub-10 nanometer accuracy. The periodicity of the holes determines the ability of the material to transmit light at any given wavelength. The advancements in developing photonic crystals could mean that the optically integrated circuits are shrunk, further enabling significant progress in areas of communications and optical computing. The emerging field of quantum computing and quantum cryptography relies on the fact that discrete energy levels increasingly dominate as smaller structures confine electromagnetic energy. Quantum computing devices and quantum cryptography will emerge in the next decade, assuming that the challenge of making complex nanostructures is solved.

Nanotechnology will play an essential role in developing sensor technology. Optical tweezers place nanostructures into patterns on surfaces. These structures aid in the development of new optical lithographic techniques. These techniques play an active role in the manufacturing of computer chips and devices such as optical biosensors with single-molecule detection capabilities. Placing components such as the sensing and power device in an area of 1 square millimeter will make use of nanofabrication techniques similar to the ones used in the fabrication of semiconductor chips. Nanotechnology will also aid in the designing of the sensing element with a more significant degree of accuracy, which may enable single-molecule detection as well. Designing such a sensing element, however, remains a significant technical challenge.

Europe has been at the forefront of basic electronics research. Several large semiconductor manufacturers such as Infineon Technologies and Philips Research have been investing quite regularly in basic nanoelectronics research with several prototype products to their credit, such as carbon nanotube transistors and nanotube-based field emission displays (FEDs). Most of the nanoelectronics research is product-oriented, and several companies are understanding conventional technology limits and looking for better options that can further faster better and cheaper devices.