# ENCYCLOPEDIA OF MATERIALS: ELECTRONICS

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# Nanobots: Self-Regulated Electronics for Health Care

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## Abstract

Nanobots are very small, self-regulated and propelled electronic devices or bots that are either pre-programmed or can be controlled from outside to do specific work such as detection, operation or diagnosis. The devices range between 0.1 and 10 micrometers and are constructed with nano scale molecules or molecular compounds. The main distinctive advantages of nanobots over other conventional or novel dosage form are complete control over the bots at any given time and very less chance of any adverse effect. This article introduces types and structure of nanobots followed by a comprehensive compilation of different applications of nanobots in medical treatment.

### Key Points

- *Nanobot* is a self-propelled device having a dimension in the nanometer range which interacts with the human body in the cellular level for targeted delivery of drug or any other precise medical treatment.

## Introduction

Nanotechnology has become the fastest-growing field in engineering, particularly in electronics, agriculture, biomedical, cosmetics, food, pharmaceuticals, and construction industries. Nanotechnology is often termed as the industrial revolution of the twenty-first century, which is continuously changing the science, education, manufacturing, communication system and the lifestyles of people around the world (Khan and Asmatulu, 2013). The concept which was still a subject of science fiction movie in 1966 on the film 'Fantastic Voyage' where a submarine crew shrunk into microscopic size and entered into a scientist's body to repair his damaged brain (Menville and Reginald, 1977; Fu and Yan, 2012) has now become a semi-reality. Nowadays, it is actually possible to create such micro or nano-sized particles programmed to treat ailments and disorders. This has been achieved through the help of nanotechnology.

Nanotechnology served as a boon and presented the mankind with its extraordinary invention of a device called 'nanobot'. The word 'nanobot' simply depicts very small (nano) robot (bot). The term nanobot came into use during the late 1990s and early 2000s. Prior to 1998, nanobots was mentioned as 'molecular machine' or 'nanomachine' or 'cell repair machine'. Eric K. Drexler and Robert A. Freitas are the two pioneers who made the nanobot term popular (Mavroidis and Ferreira, 2013; Nistor and Rusu, 2019).

Nanobots are characteristically controllable machines fabricated with nanometric components ~50–100 nm wide (Rifat *et al.*, 2019) that can interact and even perforate the cellular membrane, providing a direct pathway to the cellular level. Nanobots have the capability to achieve several single or combinatorial functions including actuation, impulsion, sensing, signaling, and information processing. These nanodevices can be applied very efficiently for drug delivery (Nistor and Rusu, 2019; Subramani and Mehta, 2018; Singh *et al.*, 2019; Zeeshan *et al.*, 2011). The nanobots are also called by different terms such as nanorobots, nanites, nanoagents and nanoids (Mavroidis and Ferreira, 2013; Rifat *et al.*, 2019). These nanodevices have been recently used in biological system control such as aiming the drugs to a particular site of action i.e. target specific delivery which would make the drug much more effective and decrease the chances of possible side effects. The main significance of control design of these nanobots is molecular manipulation to accurately diagnose and treat the disease on a cellular level accuracy. Besides, nanobots have a great advantage for controlling the amount and time of drug release through monitoring the electrical pulse (Nistor and Rusu, 2019; Subramani and Mehta, 2018). Nanobots have been found useful as bio-nanomachines of the future for the development of effective medical treatments due to their long durability, faster functionality and capability of targeted drug delivery directly to the specific diseased cells. Nevertheless, further research is to overcome the current problems such as high costs related with preliminary development, tremendously complicated design, susceptibility to electrical interference for, e.g., radio frequency or electric fields and electromagnetic pulses produced by external sources (Nistor and Rusu, 2019; Subramani and Mehta, 2018; Singh *et al.*, 2019).

The most renowned potential application sector of nanobots is to diagnose, analyze and treat cancer without noticeable adverse effect (Tripathi and Kumar, 2018). Viral infections which lead to the formation of cancer, i.e. the human papilloma virus (HPV), may be suppressed by using nanobots for targeted drug delivery system for cancer treatment. In this domain a new aspiration is to create biological nanobots using the strands of DNA to create non harmful nanobots. Nanobots can also be used for the innovative treatment of many other diseases such as AIDS, diabetes, cystic fibrosis, neurodegenerative disease, heart diseases, oral disease as well as the construction new solutions in gene therapy, surgery, nanoneedles, damaged tissue repairing, etc. Though currently no