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Nanotechnology and its Military Applications

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Abstract:

The most emerging field in science and technology with a large number of ideas and application is Nano-science and Nanotechnology (NT). It is expected that nanotechnology brings revolutionary changes in many areas with great risks and benefits. In the field nanotechnology the research in defense and development expanding very rapidly. Many countries and states are taking a serious interest in the application of nanotechnology in the defense field. Nanotechnology holds many great promises. Nanotechnology will permit a new class of weapons that will change the geopolitical landscape remains to be realized. A number of uncertain security puzzles underlying the emergence of nanotechnology have inferences for arms control, international security, defense policy, and in many other fields. For the social and economic gain, many programs were initiated globally. This paper analyses the impact of Nanotechnology on defense by studying the global trends and the evolution of nanotechnology in India is also be discussed. The current and futuristic applicability of nanotechnology for military purposes, as well as their likely impact on arms control, is also discussed.

Keywords: *Nano-technology, Impacts, Future, Defense*

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Introduction

Nano-Technology has two important but different meanings. One is that in which any technology dealing with something less than 100 Nano-meter in size. The other meaning is referred to building and designing of machines in which every chemical bond and the atom is surely specified.

The advancement of science and technology gives the structuring of matter at the scale of a nanometer (1nm = 10-9m, a billionth of a meter). As we see the advancement of nanotechnology it will become the backbone of future fundamental technology. Nanotechnology is an interdisciplinary as well as a multidisciplinary area of investigation and application. The broad spectrum of applications that nanotechnology is and will be providing to speaks of its omnipresence. Be it in electronics, textiles, agriculture, medicine, energy, cosmetics, healthcare, transport, construction, water treatment etc.

The phenomena and handling of materials at molecular, atomic, and macromolecular scales, to understand the properties which significantly differ on a large scale is generally known as Nano science.

According to the US: National Nanotechnology Initiative

"Nanotechnologies are the application of structures, devices, characterization, design, production, and systems which are controlled on the basis of size and shape on a nanometer scale. The properties like chemical, physical, biological, electrical and other behave in an individual and unique way at this scale. So the properties of uniqueness and individuality open up many new way or ideas for their application and enquiry".

Nanotechnology is the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications. Encompassing Nano scale science, engineering and technology involve imaging, measuring, modeling, and manipulating matter at this length scale.

Being an emerging technology, nanotechnology is in a promising phase of its innovation, research, and development. It is different from all the other technologies. At the current stage of development, nanotechnologies are being constantly improved and updated. For the socio-economic needs nations try to build all the possibilities offered by the modern science and technology, but there is a need for a wide range of practices and organizations.

As there are many wider applications of nanotechnology so the experts have numbered a list of top ten nanotechnology application areas which is mainly for the concern of developing countries such as India with respect to UN Millennium Development Goals (MDGs). Indian defense face many different types of threats like terrorism and rogue nations. Which are not only advanced with lethal weapons but also with biological and chemical welfare weapons. In the Indian defense system, the protective cloth used is not good enough for modern weapons. The weaknesses like bulkiness, high cost, discomfort in wearing and many others make them imperfect. The material based on nanotechnology offers a promising future in the area of defense due to its extraordinary chemical, physical, mechanical and other properties at Nano- level.

According to Shri AK Antony:

"Nanotechnology is an emerging field, which can lead to the development of new weapon systems and products that can benefit our nation".

Nanotechnology offers many features which will make it suitable for many applications. The properties offered by nanotechnology include:

- Light-weight
- Highly adaptive structure
- RF tailored properties including, stealth and camouflage
- Hardness and all-impacts resistance

Global Trends

To influence the abilities of nanotechnology the world wide governments have launched many initiatives and programs for the economic and social gains. In 2005, more than 62 countries launched national specific activities.

In 2001, the USA announced the National Nanotechnology Initiative (NNI) these efforts of research and development (R&D) was significantly promoted over the world. National Nanotechnology Initiative is the most inclusive R&D programme in the world with the technology of Nano-science. On the groundwork laid by the NNI Most advanced countries have based their own programme.

The National Nanotechnology Initiative mainly focused on the development and research of Nano-scale science for the benefit of security and economy.

- Most of the countries in Europe have government supported nanotechnology research and development (R&D) initiatives.
- Through its medium and long-term programme, China has also invested in nanotechnology.
- To provide a structure for the responsible development of empowering technologies such as nanotechnology and other new technologies Australian Government launched National Enabling Technologies Strategy (NETS).
- Taiwan develops the world's first government-established system for certifying Nano-products.

On nanotechnology research and development, globally the government spend more than US$ 10 billion per year. The total government funding for nanotechnology research worldwide was more than US$ 65 billion by the end of the year 2011.

Evolution of Nanotechnology in India

To promote the research in frontier areas of science and technology like Nano-material, neuroscience, robotics the national facilities and core groups were set in 1998-2002, the 9th five-year plan. Under the basic research, the planning commission supported a various number of research and development programs.

In 2000, Department of science and technology (DST) launch "Programme on Nano-materials: Science and Devices". After realizing the importance of nanomaterial many special initiatives are also launched by the DST to support and generate some end to end projects leading to products and technologies.

On "Nano-materials: Science and Devices" In 2001-2002, a set of expert group was set up by DST and in the 10th five-year plan (2002-07) government identified the need to initiate Nano-materials Science and Technology Mission (NSTM).

In 2001, under the sponsorship of the Department of Science and Technology of the Ministry of Science National Nanoscience and Nanotechnology Initiative (NSTI) was launched. Its aim is to create research in Nano-science and Nano-technology. With applications in almost every aspect of life, nanotechnology was indicated as a revolutionary technology.

To foster, develop and promote all aspects of Nano-science and nanotechnology a Mission on Nano Science and Technology (Nano Mission) was launched on May 3, 2007, by the DST. The primary objectives of the Nano mission are:

- Development of Infrastructure for Nano Science and Technology Research.
- Public-Private Partnerships and Nano Applications and Technology Development Centers
- International collaborations
- Industry-Academia partnerships to be encouraged under these programs

In 2012-2017 the Twelfth Five Year Plan, approval was passed by the government for the continuation of the mission on Nano Science and Technology in Phase-II at a total cost of Rs. 650 crore. In this new phase, great efforts were made to promote application-oriented R&D for the result of some useful technologies, products, and processes.

The development of Nanotechnology receives significant support from many government agencies, though specific funding levels are difficult to estimate. Nanotechnology research in Defense Research and Development Organization (DRDO) labs includes applications like:

- Nano-magnetic material
- Gas sensors
- Low-emissivity films and coatings
- Nano-composites
- IR reflecting coatings
- Materials for thermal insulation
- Magnetic nanoparticles to fuels and lubricants
- Polymeric Nano-composites
- Toxicity of engineered Nano-materials
- Semiconducting Nano-crystals
- Metal nanoparticles and their composites.

Nano-Technology and its Military Usage

The application of nanotechnology in defense is numerous ranging from sensing the Weapons of Mass Destruction (WMD), medical aid (infection control), to self-healing materials, combatant protection kits and in Nano-electronics.

Nanotechnology is a developing technology and in the military, the demand for in-depth research and development is more. In this section, we discussed the existing and futuristic impact of nanotechnology on the military.

Electronics/Computers/Sensors

Nanotechnology is making great development in the field of electronics. The application of NT gave a significantly increase in the performance of memory, processors, displays, solar-powered components and embedded intelligence systems and reduce the prices. NT offers the best solution for the miniaturization which is expected to help the microprocessor to run fast. The size of computers and electronics will become much smaller and much faster. This system introduced a new advancement of artificial intelligent which will be used throughout the military even in the small machinery (uniforms, rifles, glasses, mini- and micro-robots).

In some cases, the limitation of other technology comes forward with the nanotechnology enables equipment like it is possible to reduce the size of an electronic device with the help of NT but here the problem comes because the size of battery should not shrink in parallel. Therefore a micro-meter sized system needs a centimeter-sized power supply. So more research is needed to produce the Nano-electronics over these limitations.

In general, nanotechnology is expected to be revolutionary in the field of IT and making a new way of research and development. From the perspective of the military application, the need for nanotechnology in the field of computers, sensors, and electronics would fundamentally revolve around by reducing the size of gadgets and making them more efficient. With the use of nanotechnology in sensors, LEDs, and wireless communication component a network is produced not on the battlefield but also for the logistic department.

Bio-Defense

In bio-defense, nanotechnology is the fast emerging new frontier. In the development of bio-sensor nanotechnology is primarily used. In the production of chemical biological mass spectrometers, which are used to detect biological warfare agents nanotechnology is found very useful. For cell death, this technology is very helpful with this molecular targets can directly insert into the cell or simply exposed to the environment. Many cells are measured in nanometers where the numerous life activities and the interaction of protein surface takes place. By using the Nano-chips the cost of drugs and virus development can be reduced. In the field of bio-defense nanotechnology is showing immense promise in the development of various direct and indirect applications. A good amount of progress is reported in the field of bio-defense particularly in the various design of carbon-Nano-Tube (CNT).

Maritime applications

Nanotechnology shows a great potential for maritime usage. Nanotechnology is likely to be a critical component of a ship's system architecture. Mainly the design and manufactures are set on microelectronic and nanotechnology. The present work toward the development of electric warship would transform the use of navy's weaponry and manpower. Under the most harm condition, the electronic packaging of micro and Nano-scale are likely to maintain the consistency, resulting from high-current density, high temperature and power loads.

The research and development organization of US Navy's offer a critical infrastructure for performing multidisciplinary work at the Nano-scale and critical transition paths for Nano-science and Nanotechnology into the application of interest like as Combat-Safe Insensitive Munitions. To bring innovations from the bench of the navy, products like functionally classified Nano-composites are stimulating examples of nanotechnology. The advance navies take nanotechnology as an area of importance and opportunities. Nanoparticles in the views of an expert can be used to mark ships, navigable channels, fishing boats and delimiting safe heavens.

Conventional Weapons/Ammunition

It is believable that small arms and light weapons could use barrels, locks etc. made of Nano-fiber composites. The nanotechnology-based material makes the weapon stronger and lighter. Employment of advances in explosives and material, conventional guns could reduce the mass and larger ranges should be targeted. Even in the ballistic and air-breathing missiles, the reduced mass could transform into an increase in range, speed, payload and also reduce the size of the carrier. It was also said that nanotechnology-based improvised explosives and propellants are likely to enter into the use of the military within a time of decades. Guidance system which is based on nanotechnology targeting accuracy could increase markedly this is same for missiles. Nanotechnology-based armour will overcome over NT penetrators or vice versa is an open question.

Space weather forecasting

From the region of space like ionosphere the sensor based on nanostructured sensors are expected to play a vital role but the knowledge of weather near earth and the environment of solar space would become critical at this stage. The communication and navigation would be controlled by the space based system, therefore, in upcoming, the dependence of military on space belongings are likely to increase.

Soldier-worn systems

Soldier worn system which is based on the nanotechnology could sense the state of health of the wearer. The reaction of the system is done by releasing drugs or, using smart materials, by reducing wounds. By the moments of the normal body, the energy for communication could be generated.

Space and other defense applications

By the intelligent use of sensor and information technology, it can be possible to enable more accurate delivery of force and less collateral damage. The advancement of light-weight and strong material would also release great energy. In satellite manufacturing, the material used is less vulnerable corrosive material, therefore, Nano-structural material shows a prominent promising structural application. The material also very positive change in the manufacturing of cars in which the strength and weight are improved by 10 to 15 percent, with a promise of 20 to 25 percent. In designing the unmanned aerial vehicle or combat aerial vehicle nanotechnology plays a very important role.

Today's generation of satellites utilizes thruster rockets to change orbit or remain in the orbit. The fuel they carry on board is used to determine the life of this satellite. Due to inefficient and incomplete combustion of fuel such as hydrazine more than one-third of the fuel is wasted. For incomplete and inefficient combustion the main reason is onboard initiator wear out quickly and conclude to perform effectively. For enhancing the life performance of these igniters Nano-materials, such as Nano-crystalline tungsten-titanium diboridecopper composite, is probable. As a power of source satellite uses solar power apart from onboard fuel in outer space.

To reduce the weight of such solar cells, the designer of satellites are working continuously. To their conventional counterparts, space and defense scientist are trying to adopt the material like nanomaterial as an alternative material. In the defense industry, for the manufacturing of spacecraft, the lighter non-porous material like aerogels are found to be very applicable. Even with the use of aerogels many special light-weight jackets and suit could also be made.

The threat from nuclear, chemical, biological and radiological terror (WMD) nanotechnology offers a solution against the usage of chemicals like HD, GB, GD, and VX. The oxides of CaO, MgO and Al2O3 interact much faster as if compare to micro-particles and are well suited for the fast decomposition.

Conclusion: The recognition of nanotechnology is as a very strong innovation driver and it is seen as a most planned technology for the world's future economy impacting virtually all technological sectors including defense and security. India has made significant progress in nanotechnology research. Nanotechnology in India is the most emerging technology with a huge potential to address challenges. The government of India starts many initiatives for research and development on nanotechnology to increase the application in many fields. The application of nanotechnology in military offers a great future. From the development of various sensors to soldier protecting kits nanotechnology gave its own important impact. The research or defense scientist of India needs to work in tandem with their other national colleagues because there are a lot of unities in the civilian and military arenas of Nano-technology. This technology should lead to higher protection, longer endurance, more lethality, and better self-supporting capacities for the soldiers of future combat.

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