Military nanomaterials applications

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Introduction

Nanotechnology is a technology which controls production particles about nanometric dimensions. The task of nanotechnology is the development and implementation of methods of research and modeling of nanoparticles [1]. The basis of a nanomaterial definition is dimension which is the only standard of qualification, not the structure. Thus, the nanoparticles, nanograins, nanolayers, nanofibers can be classified into nanostructures, which are shown in Figures 1 and 2.

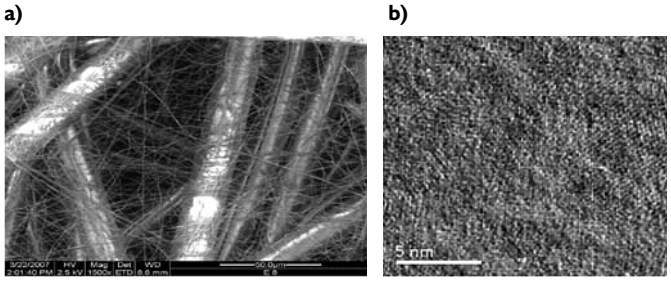

Fig. 1. One or twodimensional objects: nanofibers (a) and nanolayers (b)

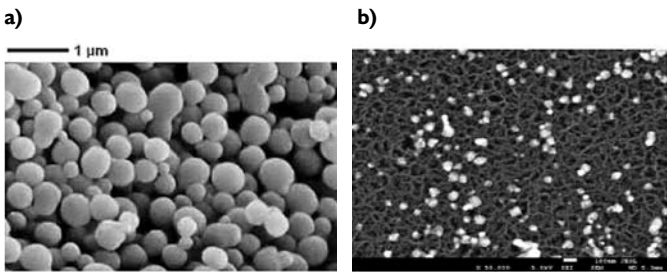

Fig. 2. Threedimensional objects: nanoparticles (a) and nanograins (b)

New obtained structures, differing in respect of the shape, dimensions and properties, are defined as "nanomaterials". Nanomaterials dimension cannot exceed 100 nm and their structures have the characteristic, physicochemical properties [2, 3]. Nanostructured materials are characterized by different, better properties (e.g. optical, magnetic or mechanical) than their micro-or macro-structural analogues. The structure and properties of nanostructures are presented by Moritz et al. [4].

The armaments industry appreciated a huge potential of nanotechnology, which offers innovative solutions of some military problems. The benefits of nanotechnology are connected with new, atypical properties of materials that are better in nanoscale than in original scale [5]. Possibilities of using nanomaterials in many branches of military sectors were created by large financial outlays for research. Military nanotechnology includes such categories as offensive and defense, the soldier and his equipment and the ability to "transfer" of nanotechnology from the army to the general community [6]. The practical applications of nanotechnology in the armaments industry are presented in Figures 3 and 4.

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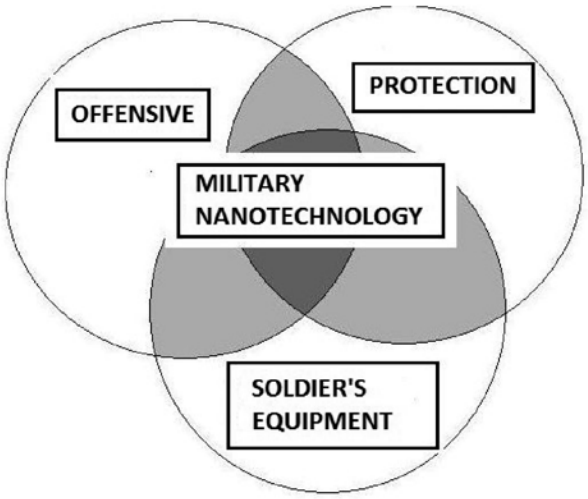

Fig. 3. Range of practical applications of nanotechnology in army

Scientists from military research establishments have taken attempt to dissolve the main problems which soldiers have on the battlefield. The main problems are heavy equipment of soldier, sleep lose, suffer injuries, enemy's advanced weapons. Soldier's survivability depends not only on his protection, but also supervision of him, a rate of enemy elimination and avoidance detection by the camouflage [7].

Nanotechnology is used to developing more effective tools to reach appointed aims. It allows to reduce weight of soldier equipment during battle operations by creating smaller and lighter devices. The task of nanotechnology is to assure faster treatment of badly injured soldiers as a result of threat/attack and improvement of soldier's efficiency, for example: for reason of sleep lose [8]. Summing, nanotechnological researches for military applications target:

- to ensure leadership in technological capability,
- to minimise battlefield casualties (soldier protection),
- to enable the acquisition of knowledge on all aspects of the enemy's activities,
- to efficiently immobilise/destroy the enemy,
- to limit access by the enemy to resources that may result in re-mobilisation.

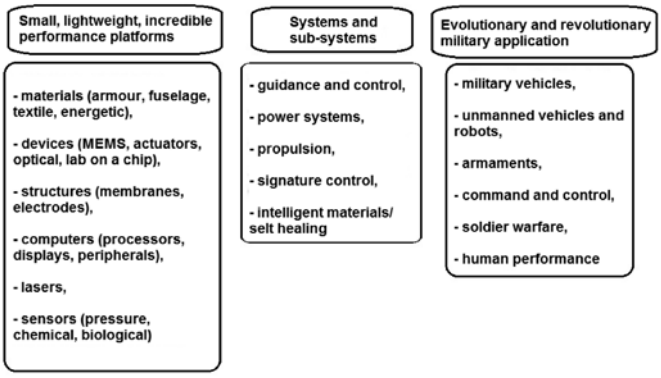

Fig. 4. Possibilities of nanotechnology applications in the armaments industry

Nanomaterials application in soldier's equipment

Equipment of each soldier consists of weapon, ammunition and electronic equipment with a source of communication and supply. Nanotechnology makes possible to drastically decrease a mass of soldier's equipment without decreasing of equipment functionality. Produced military device is smaller and lighter, and soldiers become more mobile and durable [9, 10]. The conception of the future soldier (Future Warrior Concept – FWC, was proposed by the team from Natick Soldier Center (NSC) and article writer [12]) is illustrated in Figure 5.

In addition, scientists from military investigative institutes also undertook the task of improvement the speed of threats detection, camouflage in front of them or neutralization of them.

One of leading nanotechnology institutes is Institute for Soldier Nanotechnologies (ISN), which was established in 2002. The main aim of this Institute is to create self-sufficient soldiers, who could penetrate quickly to battlefield and deal with unforeseeable conditions and situations. Specialistic uniforms which will control state of soldiers condition, support his medication, monitor his medical state and stress level are constructed. Research of bullet-proof vest is carried out to create vest with high durability, flexibility and effectiveness of detention projectiles and concurrently lighter and more mobile for user than ever before. Matrix from SiC nanofibers are used in creating flexible „armor" to be able to stop a projectile [8]. Research on changes shirt-sleeves or trouser-legs in rigid rails guard is undertaken as well. That railes guard could immobilize limbs in case of serious injuries or fractures. Carbon nanotubes are used in communication, noctovision, navigation or electronic devices, because nanotubes reduce dimension and mass of devices.

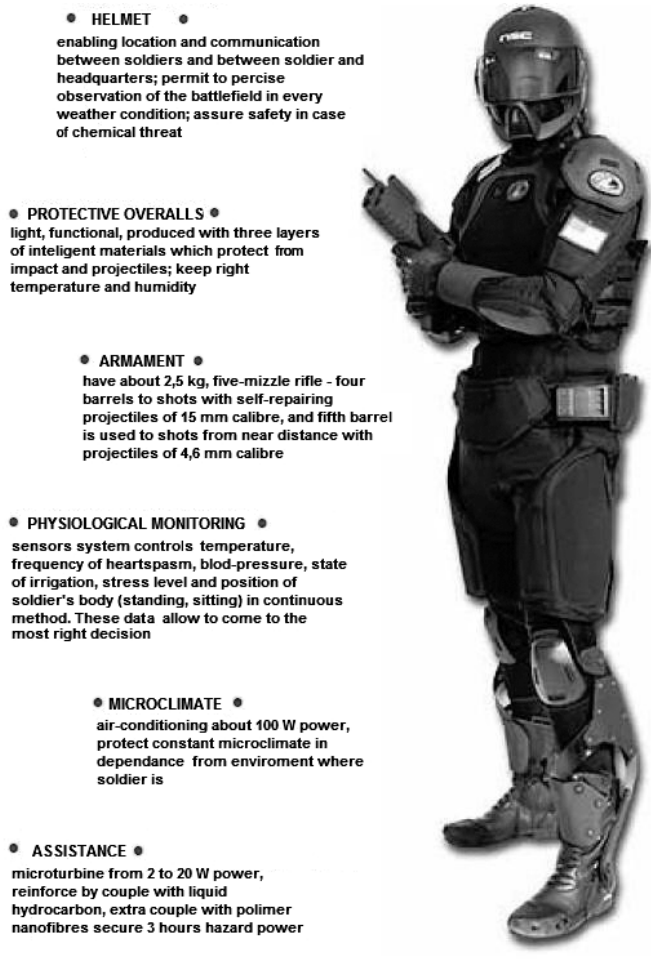

Fig. 5. The conception of future soldier [12]

Military applications of nanotechnology also include the production of various types of devices for communication and exchange of information [11], such as:

- radars used by staff and miniature unmanned vehicles,
- portable motion detectors,
- biochemical sensors,
- built-in sensors which monitor the health,
- sensors constantly monitoring condition of equipment and ammunition,
- rapid reporting systems.

Nanomaterials application in protection

The ballistic systems guard with nanomaterials application are elaborated in research units. That system will protect soldiers and military machines from projectiles and shell splinters. However, the task of soldier's uniform is not only to provide a ballistic protection and collection and transmission of information, but also medical help for injured soldiers through delivery of curatives directly into body, reducing the toxicity of biological and chemical weapons and protection from extreme weather conditions. Fabrics are impregnated with carbon nanotubes, which are embedded in form of net on polymer matrix, in aim to produce very durable and light-weight uniform (because carbon nanotubes have a high tensile modulus, good electrical properties and thermal conductivity) [11]. Nanoactive materials are used in medical care and relief for soldiers in field hospitals or on battle-field.

Nanomaterials are also used in passive armors. For example the Russian company NEVZ elaborated on production technology of ceramic armor materials on the basis of boron carbide nanopowder [13]. From these materials armor vehicles and individual bullet-proof shields are realized. According to the manufacturers a new armoured materials increase the effectiveness of protection by five or six times and decrease mass of armor by four times. New personal armors will be shell-proof of caliber 7.62 mm, whereas an armored plates, which protect vehicles, will stop projectiles of caliber 12.7 mm and 14.5 mm. The company NEVZ declared that they present the first prototype and check its real effectiveness of technology in 2014. Production of the first armors for military and service force is planned for the end of 2015.

In Poland, the Institute of Ferrous Metallurgy in cooperation with the Military Institute of Armament Technology carries out projects concerning production of superhard nanostructural materials from iron alloys. They have made attempts to apply produced materials in passive and passive-reactive armors. These nanoarmors are shell-proof from various method of action. New processed nanostructural steel grades are serving to protect combat vehicles, stationary objects and to personally protect in the form of protective vests (bullet-proof, knife-proof). The scientists explore passive nanostructural composite armors with colloidal and magnetorheological liquids. Nanostructural construction of materials on an iron alloys-based makes possible to get better useful properties (higher impact resistance) than the one of usual alloys [14–19].

An armor of vehicles is also produced from aluminum alloys with carbon nanotubes, thanks to guards are more durable and lighter. Carbon nanotubes are also used to strengthen structure of ships and aircrafts hulk.

Nanomaterials application in offensive

Material additions, called superthermites are adapted to obtain more powerful weapons. Superthermites are obtained by combining nanometals (e.g. nanoaluminium) with metal oxides (e.g. iron oxide). These materials are used in under-water explosive devices, in percussion caps to ignition of powders and in rocket propellants. The

addition of aluminum nanopowders causes increase of energetic high explosives, powders and thermites. Nanomaterials application causes serious reduction of charge/load mass and propellant without loss of weapon system efficiency [20].

It is possible to increase combustion velocity of rocket propellants which contain ammonium perchlorate (NH_4ClO_4) by addition of iron oxides or organic iron compounds to propellant composition. Preliminary research about application of nanostructural Fe_2O_3 as a combustion modifier of heterogeneous solid rocket propellants has been conducted [21]. Propellants combustion rate studies led to the conclusion that Fe_2O_3 nanopowders are better than their micrometrical analogues, and obtained propellants burn faster.

Produced heavy alloys to subcaliber and fullycaliber cores of armour-piercing shell are another nanomaterials application. Based on many years' research, tungsten alloys proved to be the best materials for application of missiles core. Tungsten alloys are characterized by concurrently high stress properties and high plasticity [22, 23]. Research of replacement of micrometrical tungsten by nanometrical equivalent was conducted in the Military University of Technology. Preliminary research has shown that tungsten nanopowders application causes better mechanical and useful properties of alloys on the basis of this metal [24].

Nanotechnology threats

Expansive development and implementation of nanotechnology to armament industry has a huge impact on whole society life, and therefore it should be directed to responsible and efficient enjoyment of knowledge and research products. Nanotechnology offers great opportunities, but also causes a serious threats for international security and military future [25].

A new, unique produced nanomaterials can have negative effects on living organisms (toxicity) [26–29]. Air-passages, skin and alimentary system are the main roads of human life threats. Disorders of air-passages and blood-system, cellular conductance or even appearance of allergic reactions can be the consequence of this threat. Therefore, a detailed and objective research of nanomaterials toxicity will only permit to effectively and properly account of them in arms industry.

Another kind of threats are risks of a military nature, which include nanoterrorism and regular warfare. Nanoterrorism consist of using advanced arms techniques as an effective tools for frighten or eliminate humans by terrorist organizations [29–31]. These organizations are a serious danger to functioning of society. For example, what was mentioned in the atricle [28], weapons were built of nanomaterials (eg. carbon nanotubes), which can't possibly be detected by metal or chemicals detection devices (eg. on airports). Nanosensors also determine threat, because they are responsible for secret data collection and acquisition. Secret informations in wrong hands could be used for terrorist activities. Protection from such threats could be the control by nanotechnology research in research institutes, invigilation of terroristic environment and creating of various kinds of devices to protect of information and test results. The regular warfares is another risk mentioned above. This threat includes creation of new weapons of mass destruction (eg. chemical, biological) which could be transferred in nanocapsules form by means of human body, animal or plant. In order to avoid such threat, people should forbid creation of this type of weapon or 'robots to kill', and civil and military sectors should co-operate to control research [31].

Socio-ethical problems are the last group of hazards. These problems concern a very low state of society knowledge on nanotechnology and its usable possibilities in many countries. As a result, these risks can cause numerous misunderstandings or even conflicts. It is very essential to increase awareness and knowledge of the society on nanotechnology by education, television programs etc.

Conclusion

Nanotechnology gives solution for many problems in scientific fields and industries. It is one of the most dynamically developing technology, which gives huge prospects and hopes to solve modern world problems. Nanomaterials, due to small dimensions and better properties than their micrometric analogues, have found wide application in arms industry. Nanomaterials are used to produce materials for soldiers protection, for communication devices, detection enemy and for armament. However keep in mind, that nanotechnology has many benefits, but it also has threats (in range of safety), which should be taken into account and eliminated at the basic research phase.

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Złoto w Moskwie dla badaczy z WETI

Złoty medal na XVII Moskiewskim Salonie Wynalazków i Innowacyjnych Technologii „ARCHIMEDES – 2014" zdobyli badacze z Wydziału Elektroniki, Telekomunikacji i Informatyki PG. Jury doceniło opracowany przez dr. inż. Roberta Bogdanowicza oraz inż. Mateusza Gardasa „Sposób otrzymywania suspensji diamentowych". To prosta i tania metoda oczyszczania i rozdrabniania proszków diamentowych, które mogą być stosowane m.in. jako zarodniki do wytwarzania diamentu na potrzeby elektroniki, markery fluorescencyjne w pomiarach biomedycznych lub centra zdalnego dostarczania leków. Nowym trendem rynkowym jest użycie proszków nanodiamentowych w produktach kosmetycznych oraz w środkach czyszczących. *(kk)*

(http://pg.edu.pl, 16.05.2014)

Wyróżnienie dla projektu PROMINE

Podczas konferencji Industrial Technologies'2014 projekt Instytutu Metali Nieżelaznych o nazwie PROMINE zdobył pierwszą nagrodę za najlepszy ukończony projekt realizowany na rzecz technologii przemysłowych w ramach Europejskich Programów Ramowych. *(kk)*

(http://www.imn.gliwice.pl, 8.05.2014)

KONFERENCJE I SPOTKANIA

Konferencja Środki Smarowe'2014

W dniach 14–16.05.2014 r. w Hotelu „Klimek SPA" w Muszynie odbyła się Międzynarodowa Konferencja Naukowo-Techniczna „Nowoczesne środki smarowe do specjalistycznych zastosowań w urządzeniach przemysłowych, transporcie i komunikacji". Organizatorami Konferencji był Pion Technologii Nafty Instytutu Nafty i Gazu – Państwowego Instytutu Badawczego oraz Stowarzyszenie Współpracy Przemysłu Naftowego i Samochodowego CEC POLSKA. W Konferencji wzięło udział ponad 80 specjalistów z kraju i zagranicy, reprezentujących m.in.: producentów środków smarowych, producentów olejów bazowych, producentów i dystrybutorów dodatków do środków smarowych, producentów i dystrybutorów aparatury badawczo-pomiarowej, a także przedstawiciele środowiska naukowego. Celem Konferencji była prezentacja najnowszej generacji środków smarowych, przeznaczonych do pracy w specjalistycznych zastosowaniach oraz metod kontroli ich przydatności eksploatacyjnej i rozwojowej. W tym kontekście Konferencja spełniła zakładaną przez organizatorów rolę i stała się platformą wymiany wiedzy i doświadczenia. *(kk)*

(http://www.inig.pl, 19.05.2014)

Konferencja Instytutu Kolejnictwa

Druga Międzynarodowa Konferencja „Nowoczesne Kierunki Ochrony Przeciwpożarowej Taboru Szynowego" odbędzie się 25 czerwca 2014 r. w siedzibie Instytutu Kolejnictwa w Warszawie.

Zapraszamy zainteresowanych ochroną przeciwpożarową w taborze szynowym (kolej, metro i tramwaje) przedstawicieli: administracji państwowej, jednostek badawczych, operatorów, producentów taboru, producentów materiałów niemetalowych i elementów pojazdów. (*em*)

(komunikat Instytutu Kolejnictwa; 8 maja 2014 r.)

Tworzywa – materiały przyszłości

Jak powstają tworzywa i poznaj ich właściwości. Dowiedz się, jakie tworzywa są produkowane w Grupie Azoty i bez których nasze życie codzienne byłoby dużo trudniejsze. 13. i 14. maja przed siedzibą Grupy Azoty w Tarnowie pracownicy spółki prezentowali tajniki oraz przyszłość tworzyw. Gośćmi specjalnymi wydarzenia byli żużlowiec Janusz Kołodziej oraz kierowca rajdowy Maciej Dreszer, którzy na co dzień wykorzystują tworzywa w używanym przez siebie sprzęcie. (*em*)

(informacja prasowa Grupy Azoty; 9 maja 2014 r.)

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