Summary

Funding and media attention for nanotechnology research sharply increased in the last 15 years. Up till now, several nanotechnology-based products have entered the market. Still, nanotechnology can be characterized as an emerging technology and potential applications are explored. In this report, the significance of nanotechnology for civil security applications is evaluated and the study provides a broad overview of upcoming nanotechnologies and application fields. The focus of this report lies on the opportunities that nanotechnology offers for security applications. Possible health or environmental risks are not discussed here.

Based on a literature review, various application fields are identified and discussed in this report: (i) detection, (ii) protection, (iii) secure identification and communication, and (iv) defense. Furthermore, nanotechnologies that are interesting for these application fields are described in more detail. The results of the literature review are complemented with outcomes of interviews (in total 27) that are conducted with researchers and experts in the field of nanotechnology, firms that develop products for security applications, and with expected end users and security partners of the Dutch Ministry of Security and Justice such as the police, the fire brigade, the Dutch Forensics Institute, the Custodial Institutions Agency, the Public Prosecution Service, the Royal Marechaussee, and the Dutch Ministry of Defense. The interviews provide insight into the needs of security partners and the requirements technologies must fulfill. Furthermore, the unique characteristics of nanotechnologies as well as expected challenges and future developments are discussed with respect to these application areas.

The detection of chemical, biological, radioactive and explosive substances is of great importance for the police, the Royal Marechaussee and the Dutch Ministry of Defense. Here, the detection of explosives receives special attention with specific requirements. At airports for example, the detection of explosives should take place from a distance, with as little intervention and inconvenience for the passengers as possible. For the police, the detection of synthetic drugs and illegal drug laboratories is a big problem for which new technologies could be valuable. These new technologies should be efficient, effective and reliable. Nanosensors for example are extremely sensitive and able to measure at the single molecule level, thus at a length scale of several nanometers. In general, it is expected that the use of sensors, especially in the health sector, increases in the coming 5-10 years. For forensic science, the detection of biological traces such as DNA, blood, semen, hair and skin is of major importance for the reconstruction of a crime. New technologies could be helpful to better detect such traces and to extract more information from them. Additionally, portable detection methods are desired by the police and the Dutch Forensics Institute to analyze traces directly at the crime scene. Here, the continuously decreasing size of sensor parts and their integration makes it possible to build portable detection tools. Next to new technologies, it is expected that digital data becomes increasingly relevant for crime investigations.

Protective clothing is of importance for the police, the fire brigade, the Custodial Institutions Agency, the Royal Marechaussee and the military. The weight reduction of protective clothing is strongly desired to reduce health problems of end users that result from heavy clothing and equipment. The presence of dangerous or cancerous substances in smoke and their penetration in uniforms of firemen are important points of attention for which solutions are requested. Nanomaterials with new and improved functionalities possibly offer a solution to improve protective clothing. Such new materials could facilitate the integration of sensors in clothing with the aim to track the position and monitor

the physical condition of firemen and police officers during an operation. Important challenges for the implementation of new materials are, next to costs, health and safety standards.

The identification of persons and the verification of the authenticity of official documents such as (foreign) passports and visa documents are of great importance for the airport security, police and the Public Prosecution Service. The security of such documents that are prone to forgery, as well as the security of money, ID cards and entrance cards for buildings can be improved with nanotechnology. By making use of properties at the nanometer scale unique identification and authentication characteristics can be created that cannot be copied. Nanotechnologies also offer solutions for the tracking and tracing of persons and for data protection. Track and trace is an important aspect for many security applications such as monitoring police officers and firemen during an operation or the tracking of travelers at transportation hubs. Additionally, in the coming 10 years, the security level for prisons is going to change and new technologies for tracing prisoners will be of interest here. In the coming 5-10 years it is expected that the market for secure authentication will grow strongly. The protection of sensitive communication is important for the police, national security institutions, organizations within the government, banks, financial institutions and for a large number of firms. Furthermore, the increasing use of sensors requires secure communication in the future. Next to secure communication, decryption is important for lawful interception and crime investigations. Decoding data is also of importance for the military to collect information about the enemy. In the future, encryption and decryption will play an increasing role in defense and information will become more important. Quantum communication, which limits eavesdropping, is already commercially available.

The technologies that are interesting for civil security applications are also of importance for defense, although they have to be more robust and applicable to different circumstances. The autonomous energy supply of equipment is here especially important. Soldiers have to walk long distances and do not return regularly to their basis. An autonomous energy supply allows them to be more independent of the infrastructure. Solar cells for instance can be applied to charge batteries and can be made more efficient with new nanomaterials. Nanomaterials can also contribute to lighter and more stable weapons or to improve camouflage pattern.

The variety in nanotechnologies for the here presented security applications is broad. This research offers an overview of available and developed technologies. To seize the chances that nanotechnologies offer it is important to stimulate the dialogue between end users and researchers in order to link technical developments to the current and future requirements of the Dutch Ministry of Security and Justice and its security partners.