



Technology Sector – Security

Sub Sector – Detection

Segment - Narcotics

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1. Title

Detection of Narcotics

Keywords: cocaine, heroine, fentanyl, drugs, narcotics, spectrometry, SERS, gamma rays, neutron analysis

2. Definition of Technology Segment

The international narcotics control board has produced a list of narcotics drugs under international control that is included in Schedule I, II and IV. The exhaustive list also provides the chemical formula and its chemical content of chemical substances considered illegal and under international control. It also provides a list of those narcotic drugs that are exempt under some provisions [1]. The segment covers detection of chemicals such as heroine, cocaine and fentanyl.

3. Short Description

Fentanyl has been reported to be 40 times more potent than heroine and has been used as a narcotic. Ion selective membrane electrodes have been reported as sensors for Fentanyl. Polyvinyl chloride based membranes have been applied with negligible interference from other chemicals to detect fentanyl citrate in injections [2].

A sea portable drug detection system can enable detecting threats such as drugs, explosives, nuclear weapons and chemical weapons behind hidden compartments of maritime vessels has been mentioned in the literature. Detection of gamma ray signature of chemicals in narcotics has been demonstrated for maritime vessels using thermal neutron analysis and fast neutron analysis. This is based on characteristic gamma rays generated by elements such as hydrogen, nitrogen and chlorine capturing thermal neutrons. The man portable detection system has been demonstrated for Heroin hydrochloride, Cocaine hydrochloride, Heroin, and Cocaine [3].

Commercially available ion mass spectrometry has been reported to have applications in detection of drugs. Ions are produced through atmospheric pressure ionisation are pulsed through an electric field to a collector, during which the time of flight is measured. The advantages offered by this technique are its portability, selectivity, high sensitivity (parts per billion) and low cost. The detector could potentially be used as a stand alone sensor or as an online system [4].

Surface enhanced Raman scattering offers very high sensitivity to detection of drugs and narcotics molecules. Physiological fluids such as blood, urine and saliva have been used in analysis of narcotics [5]. Research in identification of cocaine, heroin, amphetamines, 1, 4-benzodiazepines and various metabolites of the drugs has been conducted using SERS with high performance liquid chromatography [6]. SERS has been combined with electrophoresis and flow injection analysis to quantitatively analyse cyanide levels [7,8].

4. State of Research and Development

The section gives an overview of the technology development in relation to a specific technology. Fundamental Research is defined for this purpose as research with no particular goals of commercialisation. Applied Research is defined as research conducted in academia and industry directed towards a specific purpose and application. Prototype has been defined as Applied

Research or Fundamental Research that has found a potential market application. Technologies that are in the field trial state are defined as those that are in the process of commercialisation, and are being tested. Deployed nanotechnologies are those that have found an early stage market. Mass Market has been defined as those technologies that have been adopted by large population and are attractive high growth markets. The technologies have been mentioned are those mentioned in the literature review for narcotics detection. The scale of readiness mentioned ranges from fundamental research to mass market. A validation of their status is necessary from the economic and other technology sectors perspective. The enabling technologies for the detection of narcotics, in relation to its development status have been mentioned in table N.1 below.

Table N.1 - Comparative Research and Development Status for narcotics detection

	Fundamental Research	Applied Research	Prototype	Field Trials / Pilot plant (Pre-commercialisation)	Deployed (Commercialised)	Mass Market
Membranes		▪				
Thermal neutron analysis		▪	▪			
Fast neutron analysis		▪	▪			
Spectrometric methods				▪	▪	
SERS		▪	▪	▪		

5. Additional demand for research

Additional demand for research was mentioned in further development of SERS based detection of narcotics during the engagement process. Research directed towards quantitative aspects of SERS and their improvement were considered desirable [9].

6. Applications and Perspectives

In the expert engagement process for the technology segment, the following perspectives were observed:

- Funding research and development for detection of CBRNE and Narcotics was considered very important for society and economy of Europe.

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- The most important drivers for research and development of '*detection of CBRNE and Narcotics*' were considered technological and social impact. The technological drivers relate to cost, performance, efficiency and absence of solutions. Other secondary drivers were indicated as competitive advantage in conflict situations, safety, productivity gains and regional security policy.
 - The main drivers for R&D of '*Narcotics detection*' were mentioned to be 'cost of sensors, devices and instrumentation', 'size of detectors', and 'sensitivity of detection'. Other secondary drivers were mentioned as 'mobility of detection unit', 'time of detection', 'life time of operation' and 'accuracy of detection'.
 - The main barriers to research and development of '*detection of CBRNE and Narcotics*' were mentioned as 'availability of finance to early stage companies' and 'inadequate technology transfer from Universities'. Secondary barriers indicated were 'access to equipments, infrastructure and manufacturing facility' and 'intellectual property conflicts'. Other barriers also mentioned were 'lack of skilled personnel availability', 'lack of tax incentives' and 'lack of supportive government policy'.
 - Qualitative responses indicated to meet the challenges of 'availability of finance', EU needs to consider dual commercial use of security technology as the market was relatively smaller than US. While trends in US are towards government driven technology that is validated, EU grants are inadequate for proving technology. It was suggested that government validation of systems was necessary as laboratory systems not scaled for field use.
 - The main barriers to R&D of '*Narcotics detection*' were indicated as 'inadequate research funding', 'failure in integrating devices' and 'lack of reproducible results'. Other secondary barrier was mentioned to be 'poor detection limit'.
 - The most important functionality for detection were indicated as 'sensitivity of specie being detected', 'reproducibility of accurate results', 'retaining functionality in wide operating conditions', and 'long operating life with minimum maintenance'.
 - Other secondary desirable functionalities for detection were indicated as 'stability of detection material', 'reversibility', 'multifunctionality', 'signal transduction', 'minimal sample preparation', 'integration of detector into monitoring unit' and 'low cost'.
 - The application trends were mentioned as:
 - Development of portable and sensitive detection devices. There is a present lack of portable instruments with good sensing characteristics.
 - Operational constraints were identified as environmental changes such as temperature, humidity and large number of interferants. Mobility of detection device, and calibration for temperature and humidity were mentioned as constraints.
 - Combining SERS detection and identification of narcotics with a separation technique to address issues in reproducibility, retention of functionality and long life. In a separation coupled system, the problems associated with SERS are expected to be overcome.
 - Other operational constraints were mentioned to be calibration of measurement, skills and interpretation needed from operator.

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- The sensing method for narcotics detection that is presently deployed is spectrometric methods and bioassays for narcotics detection. Spectroscopy methods market was considered to a moderate growth market. Miniaturisation of spectroscopic methods was considered a development needs for enhanced application. Factors that would determine uptake of the technology are size, cost and sample preparation.
 - Method for narcotics detection that is expected to be deployed in the next 5 years is surface enhanced raman scattering. The SERS detection market was consider a moderate future growth market.
 - Method for narcotics detection that is expected to take over 10 years to be deployed was indicated to be based on membranes for detection.
 - North America was considered relatively better than Europe which was considered better than Asia for fundamental and applied research, industrial technology development and commercialisation for the Detection sub-sector. While Asia was considered better for cost effectiveness for technology, EU was considered better for governmental policy for innovation.

7. Current Situation within EU

The following framework 7 project has been funded by the European Commission in the Security theme that is relevant to narcotics:

- Localisation of threat substances in urban society (LOTUS) project was initiated in early 2009. The LOTUS project aims to create a system to detect the preparation of explosives and drugs during preparation and production of a terrorist plot. This will be demonstrated by detection using sensors and global infrastructure for positioning and networking [10].

8. References and Literature

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