Application Note
CBRNE 8704845

Detection of Narcotics Using the DE-tector

Abstract

The Drugs and Explosives detector (DE-tector) facilitates the fast and sensitive detection of most common natural narcotics such as opiates, cocaine and tetrahydrocannabinol (THC) related compounds as well as synthetic narcotics e.g. ecstasy and lysergic acid diethylamide (LSD).

Standard narcotic samples as well as street sold drugs, which are often contaminated with different kind of additives, could be detected at a low nanogram range.

Introduction

It is estimated that nearly 5% of global adult population consumes illicit drugs [1]. It is well known that the most worldwide taken illicit drug is cannabis followed by the synthetic produced amphetamine-type stimulants (ATS, excluded ecstasy). However, the main part of the drugs is produced only in some regions of the world. Afghanistan for example is main producer of opioids and cannabis. This centralization of drug production promotes the worldwide illicit trade. In this context, checking for illegal substances at border crossings is becoming more and more important.

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Currently different drug detection technologies are used to deal with this issue [2]. A very sensitive and fast method is the use of sniffer dogs. Disadvantages are the limited number of substances that can be found and the speed at which the animals operate. Sensitive analytical methods such as gas chromatography mass spectrometry (GC/MS) [3] or ion mobility spectrometry (IMS) are used for drug detection as well [4]. In contrast to GC/MS IMS requires no time consuming sample preparation procedures.

In the following application note the detection of chemically pure as well as street drugs using a novel IMS detector equipped with a non-radioactive ionization source is presented.

Experimental

Instrumentation

All samples were analyzed by using the DE-tector (Bruker Daltonik GmbH, Leipzig, Germany). The instrument was equipped with a low energy photoionization lamp (XPI™). For more detailed information see application note CBRNE #704242.

Test measurements

To characterize the detection performance of the DE-tector narcotic samples were directly deposited on sampling strips (a) or wiped from a test surface (b).

a) Direct deposition

For the direct deposition experiment polytetrafluoroethylene (PTFE, Teflon) coated glass fiber sampling strips with a smooth surface structure were used. Alarm limits for narcotics were determined by pipetting (1-10 µl) a known concentration (1-100 ng μl^{-1}) of standard solution directly onto the sampling strip. Due to high system sensitivity and to avoid a system overload, concentrations of less than 1 µg were analyzed. To guarantee reproduction of analysis results the organic solvent had to be completely evaporated before analysis.

b) PTFE test surface

Alarm limits for wiped surface samples were determined by pipetting (1-10 µl) a known concentration (1-100 ng μl^{-1}) of standard solution onto the PTFE test surface. After complete solvent evaporation the dry residue was wiped from test surface and directly analyzed. For wiping experiment PTFE coated glass fiber sampling strips (standard DE-tector sampling stripes) with a rough surface structure were used.

Narcotics were purchased as hydrochlorides from Lipomed GmbH (Hern, Germany). Stock solutions were prepared in methanol (LiChrosolve, Merck, Darmstadt, Germany), except cocaine, LSD and heroine.

These stock solutions were prepared in acetonitrile (LiChrosolve, Merck, Darmstadt, Germany). From the stock solutions, test solutions were prepared by dilution using organic solvents.

Analysis of street drugs

The street drug samples were solid. Small particles collected on the wooden surface of a skewer were transferred to the sampling strip and directly analyzed. For the analysis glass fiber PTFE coated sampling strips with the rough surface structure were taken.

Results

1. Alarm limits for narcotics

Narcotics can be generally classified in different ways. The classification based on the chemical structure differentiates mainly between two important classes - alkaloids and terpenoids. Alkaloids are compounds which contain a basic amino group in the chemical structure. Terpenoids have an oxygen containing functionality.

In Table 1 the alarm limits determined for directly deposited and wiped narcotics belonging to both classes are depicted. Singularly analyzed narcotics were summarized in further narcotic substance subclasses. However, alarm limits determined for direct deposited narcotics were at low nanogram levels. Due to the good collection efficiency of the sampling strips a wiped sample required only a small increase in sample amount to trigger an alarm than that of a directly deposited sample.

Table 1: Alarm limits for directly deposited and PTFE wiped narcotics determined by means of the DE-tector.

Alarm limits

Substance class	Subclass	Exemplary narcotics	Alarm limits[1] direct deposit [ng]	Sample amount to be wiped [ng]
Alkaloid	Opiates	Morphine, Heroin	≥ 2.5	≥ 50
	Tropane alkaloids	Cocaine	≥ 1	≥ 7.5
	Phenyl-alkylamines	Meth, Ecstasy	≥ 1	≥ 20
	Indole alkaloids	LSD	≥ 5	≥ 20
	Cyclic nitrogen compounds	Phency-clidine	≥ 10	≥ 25
Terpenoid	Cannabi-noids	THC	≥ 5	≥ 75

[1] Alarm limit is not identical to the detection limit of the instrument.

2. Street drugs

Street drugs are mostly mixtures characterized by the narcotics plus a number of additives or impurities left from the manufacturing process. To verify the influence of the additives and impurities on the detection result six street sold narcotic samples were analyzed using the DE-tector. Two of these six samples were white powders and the remaining four were dried parts from cannabis plants (Table 2).

All samples analyzed using DE-tector triggered a narcotic alarm. The white powders (sample 1 and 2) analyzed were mixtures consisting of extracted ingredients from the coca plant and unknown additives. Mainly there are two stable extract forms available on the market - the hydrochloride salt commonly named cocaine and the free base form called crack. However, in both samples the tropane alkaloid cocaine could be identified. Typical additives such as powder sugar or backing powder showed no influence on the detection result.

Table 2: Street drugs identified by the DE-tector.

Street drugs

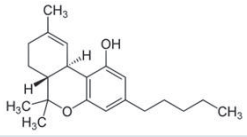
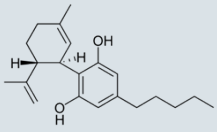
Sample number	Substance	Narcotic ingredients (concentration)	DE-tector result
1	Crack	Cocaine (unknown)	Cocaine
2	Cocaine	Cocaine (70%)	Cocaine
3	Marijuana	THC (unknown)	THC / CBD
4	Marijuana	THC (12%)	THC / CBD
5	Hashish	THC (unknown)	THC / CBD
6	Hashish	THC (8%)	THC / CBD

The cannabis samples (3-6) gave additionally to THC a cannabidiol (CBD) alarm. But, this is not surprising because besides THC CBD is one of the most important psychoactive substances of the cannabis plant [5, 6]. The female cannabis plant (*Cannabis sativa*) has small glands situated at the flowers and the upper leaves of the plant which producing a THC containing resin. By pressing and extrating the THC enriched resin (10-15% THC) [7] the so called hashish is gained. The less THC concentrated (1-3% THC) [5] dried plant parts are called marijuana (or weed).

The chemical structure of THC and CBD are further closely related to each other (Table 3).

Table 3: Chemical structure of THC and CBD.

Chemical structure

Compound	Symbol	Structure
Tetrahydro-cannabinol	THC	
Cannabidiol	CBD	

IMS spectra of standard THC and CBD showed a characteristic ion peak at a drift time of 14.1 ms in the positive mode (Figure 1). In addition, a characteristic but less intensive ion peak was observed at a drift time of 15.3 ms in the negative mode.

Based on the drift times of the characteristic ions a clear distinction between these closely related compounds was not possible. Nevertheless, small differences in THC and CBD detection were observed. The ion peaks at a drift time of 14.1 ms showed different temporal behavior for the mono-alcohol and the di-alcohol detection (Figure 2). The intensity of the peak in the positive mode showed for THC a much stronger slope compared to CBD. This criterion was additionally used to distinguish between THC and CBD.

Conclusion

Using the DE-tector different classes of narcotics, natural as well as synthetic, can be detected at a low nanogram range. Additives commonly mixed in street drugs showed no influence on the drug detection. Due to the unique twin tube design and hence the simultaneous positive and negative ion detection, a clear narcotic identification is possible.

Moreover, the evaluation of the temporal peak behavior enables the differentiation between chemical similar compounds such as THC and CBD.

IMS spectra of THC and CBD

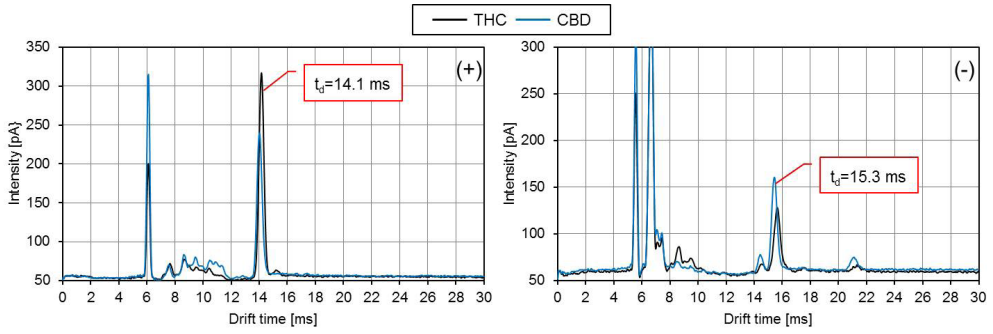


Figure 1: IMS spectra of 20 ng THC (black line) and 20 ng CBD (blue line) measured in the positive (+) and the negative (-) mode.

Temporal behaviour of THC and CBD

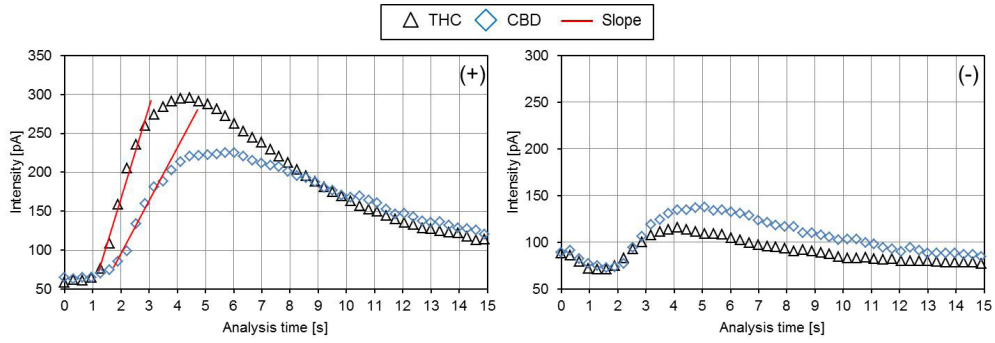


Figure 2: Peak intensity as a function of time for THC (black triangle) and CBD (blue diamond) obtained in one measurement cycle. The trend for the characteristic ion mobilities t_d=14.1 ms (positive mode) and t_d=15.3 ms (negative mode) is shown. The red lines illustrate the intensity gradient.

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