

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
15 February 2007 (15.02.2007)

PCT

(10) International Publication Number
WO 2007/017701 A1

(51) International Patent Classification:

A61B 5/117 (2006.01) H01J 49/04 (2006.01)
G01N 33/483 (2006.01) G01N 33/487 (2006.01)
G01N 27/64 (2006.01)

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(21) International Application Number:

PCT/GB2006/050234

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(22) International Filing Date: 9 August 2006 (09.08.2006)

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

0516272.2 9 August 2005 (09.08.2005) GB
0516271.4 9 August 2005 (09.08.2005) GB
60/706,439 9 August 2005 (09.08.2005) US
60/706,438 9 August 2005 (09.08.2005) US
60/795,599 28 April 2006 (28.04.2006) US
0608464.4 28 April 2006 (28.04.2006) GB
0610453.3 26 May 2006 (26.05.2006) GB
60/831,204 17 July 2006 (17.07.2006) US

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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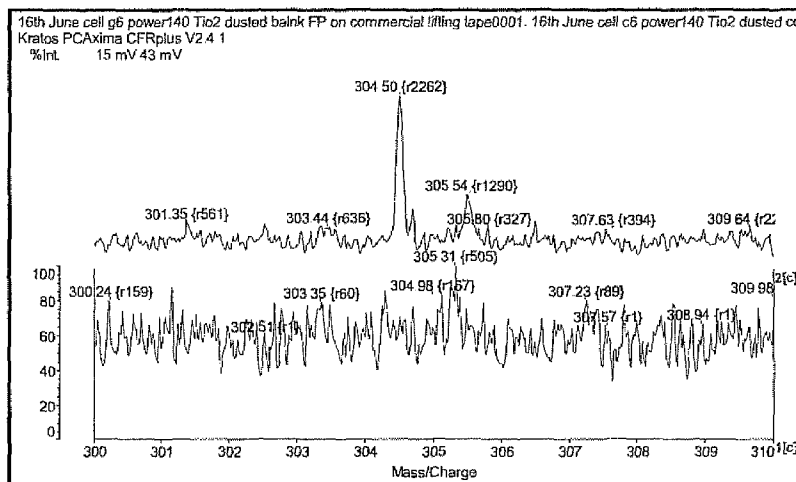
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Published:

— with international search report

[Continued on next page]

(54) Title: FINGERPRINT ANALYSIS USING MASS SPECTROMETRY



(57) Abstract: The application relates to a method for determining the presence of a residue on or within a fingerprint using mass spectrometric techniques. The mass spectrometric technique may be selected from MALDI-TOF-MS and SALDI-TOF-MS. A particulate suspension which acts as a matrix in matrix assisted laser desorption, and aids visualisation of the fingerprint, is applied to the fingerprint. Examples of suitable matrices are hydrophobic silica, titania, carbon black, fullerene, carbon nanotubes etc. Optionally, the fingerprint can be lifted using lifting tape.

WO 2007/017701 A1



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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Fingerprint Analysis Using Mass Spectrometry

Field of the invention

The invention relates to a method for determining the presence of a residue within a fingerprint using mass spectrometric techniques.

Background to the invention

Latent fingerprints contain numerous compounds such as naturally occurring compounds from the body, e.g. cholesterol, squalene and fatty acids, [1-3] or compounds which may be left on the latent fingerprint from a contact, e.g. cocaine or other drugs of abuse. Of the studies to date with this objective, use has been made of Raman spectroscopy [4,5]. In these studies, difficulty was observed in visually locating the drugs of abuse in order to perform the analysis and the method was also relatively insensitive and relatively non-specific. The most common method for the interrogation of latent fingerprints is Gas Chromatography- Mass Spectrometry (GC-MS). It has previously been shown that residues from latent fingerprints can be extracted into a solvent and analysed by GC-MS [2,3]. Such compounds include squalene and cholesterol, however levels of these on latent fingerprints vary, not only between individuals, but between times for the same individual [3]. GC-MS has also been used to detect contact residues, such as cocaine from spiked fingerprints, with a limit of detection of approx 300 µg [6] and for the detection of drugs of abuse and metabolites from commercial sweat patches down to ng per patch levels [7] and from saliva [8]. However all of the above-mentioned methods require complicated extraction procedures to be undertaken prior to analysis.

Matrix-assisted laser desorption/ionization mass spectrometry time-of-flight mass spectrometry (MALDI-TOF-MS) was developed in late 1980s by Karas and Hillenkamp, and has become established as a technique for the analysis and accurate molecular weight determination of large macromolecules such as proteins, polysaccharides, nucleic acids and synthetic polymers with high mass accuracy, and extreme sensitivity. MALDI is a "soft" ionization process that produces minimum fragmentation, and in which the energy from the laser is spent in volatilizing the matrix rather than in degrading the macromolecule. MALDI-TOF-MS has not been considered in the field of identifying

residues present on latent fingerprints. MALDI-TOF-MS is termed surface assisted laser desorption/ionisation (SALDI) when graphite, titanium dioxide or silica are used as suspension matrices for MALDI [9, 11].

5 **Summary of the invention**

The present invention discloses various materials that can be used in detection and/or imaging of fingerprints. These materials are typically also capable of acting as matrix-agents in various mass spectrometric techniques. Thus, these materials have particular properties enabling them to carry out such a “dual-purpose” role.

Thus, in one aspect of the present invention, there is provided a method of determining the presence of a residue in a fingerprint, said method comprising:

i) applying to the fingerprint a particulate matter comprising a material which (1) is capable of acting as a matrix agent or material in a matrix-assisted mass spectrometric technique; and (2) aids detection and/or imaging of a fingerprint, to form a particle-applied fingerprint; and then;

ii) subjecting the material forming the particulate-applied fingerprint to mass spectrometry so as to detect the presence or absence of the residue.

In one embodiment, the method comprises use of materials, for example, metals, metal oxides, metal nitrides and carbon, that can be used (1) as agents for visualizing fingerprints, either by themselves or combined with or embedded within a vehicle, for example a silica vehicle, and (2) as a matrix for interrogating (analyzing) prints using a matrix-assisted mass spectrometric technique. The mass spectrometry technique is used to identify the presence or absence of substances such as one or more endogenous compounds or metabolites, exogenous compounds or metabolites and/or contact residues which the fingerprint includes. In one embodiment, the mass spectrometric technique is selected from (1) MALDI-TOF-MS and (2) SALDI-TOF-MS and (3) combinations thereof.

The fingerprint to which the method is applied may be a print which has been lifted from a surface using lifting tape.

In one embodiment, the particulate matter is hydrophobic to facilitate application and contacting of the particulate matter to a fingerprint.

5 It will be understood that the term “fingerprint” includes reference to a partial print and/or to prints of other body parts and that, for example, a portion of a fingerprint to which the particulate matter has been applied may be subjected to mass spectrometry. Typically, a print is lifted from its underlying surface prior to the application of mass spectrometry, and the term “fingerprint” accordingly includes lifted fingerprints. In embodiments, the fingerprint is lifted prior to application of the particulate matter. It is contemplated that the
10 invention includes methods in which step ii) comprises subjecting particulate matter which has acquired analyte from the print to the mass spectrometry. It is further contemplated that the invention includes methods in which step (ii) comprises subjecting both fingerprint material and particulate matter to the mass spectrometry.

15 It will be understood that the terms “sample” and/or “analyte” in the context of the present invention can be taken to mean a print, a sample taken from a print and/or a residue present on or included in the print.

In some methods of the invention, a fingerprint is lifted from a surface and applied with the
20 particulate matter (processing agent), whether before or after lifting and the lifted fingerprint (at least, material comprised in the print) is then placed in a mass spectrometry apparatus. In other methods, a print is made directly on a sample support and, after application of the processing agent to the print, the sample support is placed in the mass spectrometric apparatus.

25 In one embodiment, the method further comprises locating and/or visualizing the fingerprint and interrogation of the print using the above-described mass spectrometry technique, for example, MALDI-TOF-MS and/or SALDI-TOF-MS.

30 According to an aspect of the invention, there is provided a method of determining the presence of a residue within a fingerprint located on a surface, said method comprising the steps of:

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