Science and Justice 54 (2014) 164–169

Contents lists available at ScienceDirect

Science and Justice

journal homepage: www.elsevier.com/locate/scijus

Technical note

Raman identification of drug of abuse particles collected with colored and transparent tapes

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ARTICLE INFO

Article history:
Received 18 June 2013
Received in revised form 2 December 2013
Accepted 16 December 2013

Keywords:
Drugs of abuse
Raman spectroscopy
Tape
Sample collection
Lift
Drug analysis

ABSTRACT

Raman microscopy is a useful tool for the analysis of drug particles collected with adhesive tapes. In this work, first, the spectra of thirty drugs of abuse, degradation products, metabolites, and common cutting agent standards were recorded and the Raman bands observed were summarized providing the forensic analyst useful information for the identification of drug evidence. Then, the collection of different drug particles by a fingerprint lifting tape commonly used to remove and store fingerprints and fibers, and a white and green packaging tape, followed by the subsequent identification of the drugs by confocal Raman spectroscopy was performed. The particles were analyzed on top of the tapes, trapped between glass slides and the tapes, trapped in the tape folded over itself in the case of the transparent tape, and after folding and unfolding the tape in the case of the colored tape. The results obtained by the different approaches show that both tapes did not compromise the drugs spectra. However, the use of transparent tape is preferred because this tape allows the previous visual detection of the particles. Finally, several drug and sugar particles were spread over a clean table and inside a pocket, and the particles were collected with transparent tape and then properly identified. Although good results were obtained in both cases, the amount of fibers and other substances present in the collection area made the previous detection of the particles difficult and increases the analysis time.

1. Introduction

Raman spectroscopy is a useful tool for the analysis of very different samples providing the unequivocal identification of a compound in a few seconds or minutes. The technique requires little or no sample preparation which is extremely useful for non-destructive analysis, feature that makes it optimal for the analysis of forensic samples like drugs of abuse. In fact, a review recently published by West and Went [1] considers the identification and quantification of drugs of abuse by Raman spectroscopy in different types of forensic evidence. Another advantage of the Raman technique is that it allows the sample measurement through translucent plastic and glass containers avoiding the need to open sealed bottles or bags [1], and therefore, improving personal safety and reducing potential contamination. On the other hand, the Raman related techniques and the continuous technical advances in the technique reveal numerous possibilities for the application of Raman methods for detection and analysis of drugs of abuse. The use of portable Raman spectrometers able to identify drugs of abuse in airports [2], the use of spatially offset Raman spectroscopy (SORS) to detect cocaine concealed inside transparent glass bottles containing alcoholic beverages [3], the application of surface-enhanced Raman spectroscopy (SERS) to detect trace amounts of abusing drugs in saliva [4], and the use of Raman microscopy to detect drug particles trapped between fibers [5], in fingerprints [6], on human nail [7], or banknotes [8] are only a few examples of the potential of the technique.

Regarding Raman microscopy, it allows the identification of microparticles that can be transferred onto the suspect's cloths, hands, and possessions during handling of drugs [9]. This advantage, combined with the abovementioned fact that sample measurement through translucent plastic can be performed using the Raman technique, allows the use of adhesive tape for the collection of drug particles and their subsequent Raman identification. West and Went [10] studied the possibility to analyze drugs of abuse in contaminated fingerprints deposited on clean glass slides that had been treated with two types of powders (aluminum and iron based powders). Additionally, they examined the contaminated fingerprints developed with powders and then lifted them with lifting tape and hinge lifters. The authors claimed that the application of powders to the contaminated fingerprints or the combined use of

Abbreviations: SERS, surface-enhanced Raman spectroscopy; SORS, spatially offset Raman spectroscopy.

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http://dx.doi.org/10.1016/j.scijus.2013.12.003

Table 1
Raman bands for thirty drugs of abuse, degradation products, metabolites and common cutting agents. Bands are labeled as w, weak; m, medium; s, strong; and vs, very strong according to their relative intensity (0–25%, 25–50%, 50–75%, and 50–100%, respectively) to the most intense band (100%, labeled with *).

Drug	Raman bands
Barbiturates	
Allobarbital	1729*, 1685w, 1641vs, 1438w, 1414w, 1367w, 1311w, 1297m, 1272w, 1226w, 1097w, 1043w, 1000w, 958w, 936w, 898w, 839w, 676w, 644vs, 598s, 497m, 417s
Amobarbital	1727m, 1687m, 1448w, 1339w, 1313w, 1282w, 1147m, 1076m, 998w, 960m, 832m, 617w, 627*, 496w, 439w, 411m
Barbital	1761s, 1731w, 1701m, 1447w, 1383w, 1242w, 1155w, 1024w, 625*, 491w, 452w, 418w
Phenobarbital	1763w, 1751m, 1708w, 1695w, 1597w, 1583w, 1462w, 1300w, 1193w, 1178w, 1163m, 1148w, 1080w, 1036m, 1003s, 932w, 716w, 639*, 629m, 617m, 559w, 491w, 446w, 411m, 401w
Pentobarbital	1759s, 1702m, 1462w, 1447w, 1327w, 1274w, 1162w, 1147w, 1103w, 1072w, 1021w, 941w, 915w, 870w, 856w, 740w, 627*, 510w, 490m, 459w, 422m
Secobarbital	1741*, 1697w, 1638m, 1443w, 1413w, 1299w, 1255w, 1144w, 1107w, 1033w, 984w, 912w, 877w, 653m, 622m, 503w, 404w
Benzodiazepines	
Chlordiazepoxide	1616m, 1598vs, 1588vs, 1545m, 1516*, 1493m, 1466s, 1446s, 1428w, 1398w, 1363m, 1316vs, 1284*, 1213m, 1153m, 1096w, 1030w, 1001s, 980w, 922w, 851w, 768w, 737w, 679m, 651w, 618w, 598w, 563w, 521w, 501w, 480w, 431w, 403w
Diazepam	1682w, 1592*, 1573m, 1560m, 1482w, 1448w, 1419w, 1399w, 1341w, 1313m, 1270w, 1256w, 1201w, 1167s, 1142w, 1127w, 1104w, 1075w, 1027w, 998m, 986m, 812w, 787w, 763w, 740w, 691m, 630w, 618w, 555w, 518w, 453w
Flunitrazepam	1610m, 1578m, 1343vs, 1334*, 1211w, 1168m, 1127w, 1099m, 1074w, 883w, 754w, 695w, 633w, 482w
Nitrazepam	1618w, 1606w, 1597w, 1573w, 1507w, 1340*, 1307w, 1258w, 1190w, 1157m, 1097w, 1032w, 1000m, 957w, 886w, 742w, 682w, 556w
Cannabinoids	
Cannabidiol	1659*, 1640s, 1621m, 1581w, 1429s, 1398w, 1367m, 1339m, 1308m, 1217w, 1172w, 1147w, 1131w, 1100m, 1076m, 1012w, 981w, 962w, 920w, 894w, 857w, 800w, 773s, 647w, 584m, 544s, 531w, 520w, 478w
Cannabinol	1619vs, 1608*, 1582m, 1568w, 1501m, 1457w, 1433w, 1401w, 1344m, 1325m, 1297vs, 1281s, 1239w, 1190w, 1152m, 1110w, 1025w, 993w, 917w, 895w, 860w, 771w, 708w, 659w, 615w, 527w, 500w, 406w
Tropane alkaloids	
Cocaine	1734w, 1709m, 1602w, 1447w, 1393w, 1373w, 1316w, 1274w, 1120w, 1180w, 1162w, 1117w, 1070w, 1029w, 1003*, 966w, 896w, 872w, 848m, 808w, 787m, 729w, 677w, 651w, 618w, 522w
Ecgonine	1685m, 1488w, 1469w, 1456w, 1335w, 1299w, 1258w, 1242w, 1224w, 1211w, 1184m, 1166w, 1146w, 1093w, 1047m, 1017w, 987w, 953w, 930w, 895m, 874m, 784*, 764m, 742w, 729w, 701w, 617w, 553w, 418w
Phenethylamines	
Amphetamine sulfate	1605w, 1582w, 1454w, 1206m, 1180w, 1157w, 1101w, 1029m, 999*, 970m, 947w, 839w, 821w, 743w, 620m, 598w
Fenethylline	1700vs, 1659s, 1606s, 1582w, 1544w, 1478w, 1438m, 1411m, 1396w, 1370m, 1351w, 1330s, 1306m, 1286m, 1257m, 1236w, 1206w, 1193w, 1181w, 1151w, 1073m, 1041w, 1031m, 1002*, 931w, 905w, 874w, 847w, 823w, 802m, 768w, 759w, 739w, 703w, 664m, 620w, 601w, 561s, 524w, 502m, 448m
MDEA	1631w, 1609w, 1500w, 1485w, 1457m, 1442w, 1405w, 1366m, 1343w, 1308w, 1279w, 1241s, 1134w, 1101w, 1075w, 1040w, 941w, 930w, 886w, 844m, 812*, 771m, 714s, 632w, 609w, 535m, 493w, 460w, 437w, 422w
MDMA	1629w, 1607w, 1502w, 1445m, 1404w, 1365m, 1333w, 1303w, 1248m, 1099w, 1067w, 1043w, 1012w, 940w, 881w, 832w, 808*, 770m, 713m, 633w, 607w, 526w, 476w, 415w
Methamphetamine	1064m, 1585w, 1454w, 1357w, 1310w, 1234w, 1210m, 1181w, 1160w, 1082w, 1061w, 1029w, 1019w, 1003*, 987w, 915w, 887w, 837m, 802w, 750w, 621w, 593w, 520w, 426w
Opiates	
6-Monoacetylmorphine	1725w, 1633s, 1480w, 1450w, 1439w, 1424w, 1338m, 1314w, 1285w, 1241w, 1223w, 1208w, 1196w, 1173w, 1158w, 1133w, 1113w, 1092m, 1055w, 1033w, 1012w, 986w, 941w, 911w, 877w, 842w, 819w, 768w, 710w, 672w, 662w, 626*, 603m, 581w, 568w, 530m, 486m, 449s, 438m, 416m
Acetylcodeine	1740w, 1631s, 1602w, 1459s, 1417w, 1355w, 1336w, 1304w, 1284m, 1265m, 1242w, 1223m, 1189w, 1137w, 1118m, 1088w, 1075w, 1042w, 1010w, 987w, 951w, 942w, 921w, 907w, 869m, 846m, 816w, 784w, 766w, 741w, 695w, 678w, 651w, 627s, 607w, 586w, 561w, 529m, 508w, 474w, 452s, 430*
Heroin	1763w, 1736m, 1659m, 1634m, 1487w, 1473w, 1444m, 1427m, 1393w, 1370w, 1342m, 1323m, 1303w, 1284w, 1271w, 1259w, 1230s, 1205w, 1184w, 1156w, 1141w, 1104w, 1081w, 1060m, 1021w, 970w, 939w, 909w, 871m, 833w, 820w, 797w, 774w, 761w, 733w, 696w, 643w, 629s, 618*, 586w, 561w, 551w, 529m, 495m, 464m, 445m, 419m, 403w
Morphine	1638m, 1473w, 1447w, 1419w, 1358w, 1329m, 1309w, 1283w, 1253w, 1204w, 1178w, 1150w, 1119w, 1086w, 1044w, 1032w, 982w, 963w, 945w, 872w, 833w, 799w, 759w, 708w, 676w, 653w, 628*, 607vs, 555w, 529m, 490w, 453w, 441w
Papaverine	1633w, 1607m, 1593w, 1530w, 1510m, 1487m, 1440m, 1408*, 1388s, 1349s, 1330w, 1266w, 1230w, 1194w, 1155w, 1085w, 1027w, 942w, 903w, 831w, 808w, 785w, 769w, 743m, 715w, 664w, 648w, 564w, 534w, 463w
Thebaine	1667w, 1602*, 1421w, 1371w, 1332w, 1275w, 1228w, 1183w, 1098w, 1066w, 1049w, 888w, 865w, 641w, 603w, 502w, 460w
Other drugs	
Caffeine	1695m, 1654w, 1597m, 1357m, 1325vs, 1281m, 1238w, 1067w, 1018w, 924w, 798w, 738m, 640m, 552*, 480m, 441m
Diphenhydramine	1596w, 1580w, 1430w, 1378w, 1292w, 1186w, 1083w, 1027w, 998*, 833w, 758w, 614w, 525w
Methaqualone	1727s, 1647s, 1607m, 1580*, 1482m, 1386m, 1358s, 1331w, 1291w, 1263s, 1250vs, 1160w, 1130w, 1111w, 1086w, 1051m, 1017s, 874w, 795w, 686s, 660m, 631w, 618w, 575w, 557w, 538w, 453m
Pemoline	1720m, 1660w, 1604w, 1587w, 1276w, 1202w, 1025m, 1002*, 931, 865w, 765w, 682w, 656vs, 626w, 529w, 487w
Procaine	1672s, 1607m, 1593*, 1569w, 1520w, 1443w, 1373w, 1308w, 1276s, 1167m, 867m, 849m, 637w, 620w, 494w