



Universiteit
Leiden
The Netherlands

Nanofluidic tools for bioanalysis : the large advantages of the nano-scale

Janssen, K.G.H.

Citation

Janssen, K. G. H. (2013, December 19). *Nanofluidic tools for bioanalysis : the large advantages of the nano-scale*. Retrieved from <https://hdl.handle.net/1887/22946>

Version: Corrected Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/22946>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/22946> holds various files of this Leiden University dissertation

Author: Janssen, Kjeld G.H.

Title: Nanofluidic tools for bioanalysis : the large advantages of the nanoscale

Issue Date: 2013-12-19

Bibliography

1. A. Deyati, E. Younesi, M. Hofmann-Apitius, and N. Novac, Drug Discovery Today **18**, 614 (2013).
2. G. F. Wu and E. Alvarez, Neurologic Clinics **29**, 257 (2011).
3. R. Hargreaves, Headache **47**, S26 (2007).
4. H. A. van Wietmarschen, Ph.D. thesis, Leiden/Amsterdam Center for Drug Research, Leiden University (2012).
5. J. J. Kamphorst, Ph.D. thesis, Leiden University (2010).
6. A. M. Henney, Embo Reports **10**, S9 (2009).
7. J. van der Greef and R. N. McBurney, Nature Reviews Drug Discovery **4**, 961 (2005).
8. J. van der Greef, S. Martin, P. Juhasz, A. Adourian, T. Plasterer, E. R. Verheij, and R. N. McBurney, Journal of Proteome Research **6**, 1540 (2007).
9. J. de Boer, M. Boomkamp, F. Broekhuijsen, P. Cheung, M. Danz, T. Douma, K. V., M. van Oppenraay, and Schutte, eds., *Farmacotherapeutisch Kompas* (College van Zorgverzekeringen, 2013).
10. J. van der Greef, T. Hankemeier, and R. N. McBurney, Pharmacogenomics **7**, 1087 (2006).
11. T. W.-M. Fan, A. N. Lane, and R. M. Higashi, eds., *The Handbook of Metabolomics* (Humana Press, 2012).
12. W. B. Dunn, D. I. Broadhurst, H. J. Atherton, R. Goodacre, and J. L. Griffin, Chemical Society Reviews **40**, 387 (2011).
13. M. M. Koek, F. Bakels, W. Engel, A. van den Maagdenberg, M. D. Ferrari, L. Coulier, and T. Hankemeier, Analytical Chemistry **82**, 156 (2010).
14. P. Nemes, A. M. Knolhoff, S. S. Rubakhin, and J. V. Sweedler, Acs Chemical Neuroscience **3**, 782 (2012).
15. O. Yanes, Nature Chemical Biology **9**, 471 (2013).
16. R. Trouillon, M. K. Passarelli, J. Wang, M. E. Kurczy, and A. G. Ewing, An-

- lytical Chemistry **85**, 522 (2013).
- 17. D. C. Harris, *Quantitative Chemical Analysis* (W. H. Freeman, 2011).
 - 18. M. Noga, F. Sucharski, P. Suder, and J. Silberring, Journal of Separation Science **30**, 2179 (2007).
 - 19. S. Vankrunkelsven, D. Clicq, D. Cabooter, W. De Malsche, J. G. E. Gardiners, and G. Desmet, Journal of Chromatography A **1102**, 96 (2006).
 - 20. X. Wang, J. Kang, S. Wang, J. J. Lu, and S. Liu, Journal of Chromatography A **1200**, 108 (2008).
 - 21. G. Desmet and S. Eeltink, Analytical Chemistry **85**, 543 (2013).
 - 22. N. J. Petersen and S. H. Hansen, Electrophoresis **33**, 1021 (2012).
 - 23. E. V. Mosharov and D. Sulzer, Nature Methods **2**, 651 (2005).
 - 24. Y. F. Cheng and N. J. Dovichi, Science **242**, 562 (1988).
 - 25. S. C. Terry, J. H. Jerman, and J. B. Angell, Ieee Transactions On Electron Devices **26**, 1880 (1979).
 - 26. A. Manz, N. Gruber, and H. M. Widmer, Sensors and Actuators B-chemical **1**, 244 (1990).
 - 27. D. Janasek, J. Franzke, and A. Manz, Nature **442**, 374 (2006).
 - 28. P. Vulto, S. Podszun, P. Meyer, C. Hermann, A. Manz, and G. A. Urban, Lab On A Chip **11**, 1596 (2011).
 - 29. Fluidigm, *Chips and kits* (2013).
 - 30. A. Floris, S. Staal, S. Lenk, E. Staijen, D. Kohlheyer, J. Eijkel, and A. van den Berg, Lab On A Chip **10**, 1799 (2010).
 - 31. S. M. Nie and S. R. Emery, Science **275**, 1102 (1997).
 - 32. D. J. Harrison, K. Fluri, K. Seiler, Z. H. Fan, C. S. Effenhauser, and A. Manz, Science **261**, 895 (1993).
 - 33. L. Chen, J. E. Prest, P. R. Fielden, N. J. Goddard, A. Manz, and P. J. R. Day, Lab On A Chip **6**, 474 (2006).
 - 34. A. Arora, G. Simone, G. B. Salieb-Beugelaar, J. T. Kim, and A. Manz, Analytical Chemistry **82**, 4830 (2010).
 - 35. G. B. Salieb-Beugelaar, G. Simone, A. Arora, A. Philippi, and A. Manz, Analytical Chemistry **82**, 4848 (2010).
 - 36. J. R. Kraly, R. E. Holcomb, Q. Guan, and C. S. Henry, Analytica Chimica Acta **653**, 23 (2009).
 - 37. R. B. Schoch, J. Y. Han, and P. Renaud, Reviews of Modern Physics **80**, 839 (2008).
 - 38. W. Sparreboom, A. van den Berg, and J. C. T. Eijkel, Nature Nanotechnology **4**, 713 (2009).
 - 39. M. L. Kovarik and S. C. Jacobson, Analytical Chemistry **81**, 7133 (2009).
 - 40. L. N. Geng, P. Jiang, J. D. Xu, B. Q. Che, F. Qu, and Y. L. Deng, Progress In Chemistry **21**, 1905 (2009).
 - 41. H. Daiguji, Chemical Society Reviews **39**, 901 (2010).
 - 42. J. C. T. Eijkel and A. van den Berg, Microfluidics and Nanofluidics **1**, 249 (2005).
 - 43. J. Haneveld, H. Jansen, E. Berenschot, N. Tas, and M. Elwenspoek, Journal

- of Micromechanics and Microengineering **13**, Natl Inst R&D Microtechnol (2003).
- 44. F. Detobel, V. Fekete, W. De Malsche, S. De Bruyne, H. Gardeniers, and G. Desmet, Analytical and Bioanalytical Chemistry **394**, 399 (2009).
 - 45. M. Kato, M. Inaba, T. Tsukahara, K. Mawatari, A. Hibara, and T. Kitamori, Analytical Chemistry **82**, 543 (2010).
 - 46. S. Pennathur and J. G. Santiago, Analytical Chemistry **77**, 6772 (2005).
 - 47. S. Pennathur and J. G. Santiago, Analytical Chemistry **77**, 6782 (2005).
 - 48. A. J. Bard and L. R. Faulkner, *Electrochemical Methods, Fundamentals and Applications* (John Wiley & Sons, Inc., New York, USA, 1980).
 - 49. Q. S. Pu, J. S. Yun, H. Temkin, and S. R. Liu, Nano Letters **4**, 1099 (2004).
 - 50. T. A. Zangle, A. Mani, and J. G. Santiago, Chemical Society Reviews **39**, 1014 (2010).
 - 51. Q. Yu and Z. Silber-Li, Microfluidics and Nanofluidics pp. 1–9 (2011).
 - 52. F. Kohlrausch, Annalen der Physik und Chemie **298**, 209 (1897).
 - 53. F. Everaerts, J. Beckers, and T. P. Verheggen, *Isotachophoresis: theory, instrumentation, and applications*, Electrophoresis Library 1 (Elsevier Scientific Publishing Company, Amsterdam, Hoboken, USA, 1976).
 - 54. C. J. Holloway and I. Trautschold, Fresenius Zeitschrift Fur Analytische Chemie **311**, 81 (1982).
 - 55. P. Boček, M. Deml, P. Gebauer, and V. Dolník, *Analytical Isotachophoresis*, Electrophoresis Library 1 (Wiley-VCH, Weinheim, Switzerland, 1988).
 - 56. J. Pospichal, P. Gebauer, and P. Boček, Chemical Reviews **89**, 419 (1989).
 - 57. B. Jung, R. Bharadwaj, and J. G. Santiago, Analytical Chemistry **78**, 2319 (2006).
 - 58. T. K. Khurana and J. G. Santiago, Analytical Chemistry **80**, 6300 (2008).
 - 59. M. Bercovici, G. V. Kaigala, C. J. Backhouse, and J. G. Santiago, Analytical Chemistry **82**, 1858 (2010).
 - 60. S. S. Bahga, G. V. Kaigala, M. Bercovici, and J. G. Santiago, Electrophoresis **32**, 563 (2011).
 - 61. P. A. Walker, M. D. Morris, M. A. Burns, and B. N. Johnson, Analytical Chemistry **70**, 3766 (1998).
 - 62. V. Dolník, S. R. Liu, and S. Jovanovich, Electrophoresis **21**, 41 (2000).
 - 63. K. Sueyoshi, F. Kitagawa, and K. Otsuka, Journal of Separation Science **31**, 2650 (2008).
 - 64. P. Smejkal, D. Bottenus, M. C. Breadmore, R. M. Guijt, C. F. Ivory, F. Foret, and M. Macka, Electrophoresis **34**, 1493 (2013).
 - 65. Y.-C. Wang, A. L. Stevens, and J. Han, Analytical Chemistry **77**, 4293 (2005).
 - 66. J. G. Shackman and D. Ross, Electrophoresis **28**, 556 (2007).
 - 67. J. G. Shackman and D. Ross, Analytical Chemistry **79**, 6641 (2007).
 - 68. S. J. Kim, Y.-A. Song, and J. Han, Chemical Society Reviews **39**, 912 (2010).
 - 69. R. K. Anand, E. Sheridan, D. Hlushkou, U. Tallarek, and R. M. Crooks, Lab On A Chip **11**, 518 (2011).

70. J. Astorga-Wells and H. Swerdlow, *Analytical Chemistry* **75**, 5207 (2003).
71. M. Shen, H. Yang, V. Sivagnanam, and M. A. M. Gijs, *Analytical Chemistry* **82**, 9989 (2010).
72. S. H. Ko, Y.-A. Song, S. J. Kim, M. Kim, J. Han, and K. H. Kang, *Lab On A Chip* **12**, 4472 (2012).
73. R. J. Dijkstra, F. Ariese, C. Gooijer, and U. A. T. Brinkman, *Trac-trends In Analytical Chemistry* **24**, 304 (2005).
74. M. Fleischmann, P. J. Hendra, and A. J. Mcquillan, *Chemical Physics Letters* **26**, 163 (1974).
75. M. Moskovits, *Reviews of Modern Physics* **57**, 783 (1985).
76. M. Moskovits, *Journal of Raman Spectroscopy* **36**, 485 (2005).
77. K. Kneipp, H. Kneipp, I. Itzkan, R. R. Dasari, and M. S. Feld, *Journal of Physics-condensed Matter* **14**, PII S0953 (2002).
78. J. Han and H. G. Craighead, *J. Vac. Sci. Technol. A* **17**, 2142 (1999).
79. J. P. Alarie, H. A.B., S. C. Jacobsoni, A. P. Baddorf, L. Feldman, and J. M. Ramsey, in *7th International conference on miniaturized chemical and biochemical analysts systems* (2003).
80. C. K. Harnett, G. W. Coates, and H. G. Craighead, *Journal of Vacuum Science & Technology B* **19**, Amer Vacuum Soc; IEEE Electron Device Soc; Opt Soc Amer (2001).
81. H. Cao, Z. N. Yu, J. Wang, J. O. Tegenfeldt, R. H. Austin, E. Chen, W. Wu, and S. Y. Chou, *Appl. Phys. Lett.* **81**, 174 (2002).
82. N. R. Tas, J. W. Berenschot, P. Mela, H. V. Jansen, M. Elwenspoek, and A. V. den Berg, *Nano Lett.* **2**, 1031 (2002).
83. X. Chen, R. Ji, M. Steinhart, A. Milenin, K. Nielsch, and U. Gosele, *Chem. Mater.* **19**, 3 (2007).
84. M. Wang, N. Jing, C. B. Su, J. Kameoka, C. K. Chou, M. C. Hung, and K. A. Chang, *Appl. Phys. Lett.* **88**, 033106 (2006).
85. J. C. T. Eijkel, J. Bomer, N. R. Tas, and A. V. den Berg, *Lab On A Chip* **4**, 161 (2004).
86. P. Muller-Buschbaum, E. Bauer, E. Maurer, K. Schlogl, S. V. Roth, and R. Gehrke, *Appl. Phys. Lett.* **88**, 083114 (2006).
87. D. Mijatovic, J. C. T. Eijkel, and A. V. den Berg, *Lab On A Chip* **5**, 492 (2005).
88. S. Pennathur and J. G. Santiago, *Analytical Chemistry* **77**, 6772 (2005).
89. S. Pennathur and J. G. Santiago, *Analytical Chemistry* **77**, 6782 (2005).
90. S. Ahuja, *Selectivity and Detectability Optimizations in HPLC* (John Wiley & Sons, Inc., New York, 1986).
91. R. E. G. van Hal, J. C. T. Eijkel, and P. Bergveld, *Adv. Colloid Interface Sci.* **69**, 31 (1996).
92. S. A. Smith and W. A. Pretorius, *Water Sa* **28**, 395 (2002).
93. H. Diehl and R. Markuszewski, *Talanta* **36**, 416 (1989).
94. E. W. Washburn, *Phys. Rev. Lett.* **17**, 273 (1921).
95. N. R. Tas, J. Haneveld, H. V. Jansen, M. Elwenspoek, and A. V. den Berg, *Appl. Phys. Lett.* **85**, 3274 (2004).

96. P. W. Atkins, *Physical Chemistry* (Oxford University Press, Oxford, 1998).
97. C. G. Armistead, A. J. Tyler, F. H. Hambleton, S. A. Mitchell, and J. A. Hockey, *J. Phys. Chem.* **73**, 3947 (1969).
98. J. A. Davis, R. O. James, and J. O. Leckie, *J. Colloid Interface Sci.* **63**, 480 (1978).
99. L. Bousse, Ph.D. thesis, Twente University of Technology, Enschede (1982).
100. T. Hiemstra and W. H. V. Riemsdijk, *Colloids Surfaces* **59**, 7 (1991).
101. N. F. Bogdanova, A. V. Klebanov, L. E. Ermakova, and M. P. Sidorova, *Colloid Journal* **64**, 389 (2002).
102. D. P. J. Barz, *Microfluidics and Nanofluidics* **7**, 249 (2009).
103. G. Garcia-Schwarz, M. Bercovici, L. A. Marshall, and J. G. Santiago, *Journal of Fluid Mechanics* **679**, 455 (2011).
104. Y. J. Oh, A. L. Garcia, D. N. Petsev, G. P. Lopez, S. R. J. Brueck, C. F. Ivory, and S. M. Han, *Lab On A Chip* **9**, 1601 (2009).
105. N. F. Y. Durand, C. Dellagiacoma, R. Goetschmann, A. Bertsch, I. Marki, T. Lasser, and P. Renaud, *Analytical Chemistry* **81**, 5407 (2009).
106. R. B. Schoch, A. Bertsch, and P. Renaud, *Nano Letters* **6**, 543 (2006).
107. K. G. H. Janssen, H. T. Hoang, J. Floris, J. de Vries, N. R. Tas, J. C. T. Eijkel, and T. Hankemeier, *Analytical Chemistry* **80**, 8095 (2008).
108. J. E. Prest, S. J. Baldock, P. R. Fielden, N. J. Goddard, and B. J. T. Brown, *Journal of Chromatography A* **1051**, 221 (2004).
109. T. K. Khurana and J. G. Santiago, *Lab On A Chip* **9**, 1377 (2009).
110. A. Wainright, S. J. Williams, G. Ciambrone, Q. F. Xue, J. Wei, and D. Harris, *Journal of Chromatography A* **979**, 69 (2002).
111. D. J. Wang and S. Bodovitz, *Trends In Biotechnology* **28**, 281 (2010).
112. R. N. Zare and S. Kim, *Annual Review of Biomedical Engineering* **12**, 187 (2010).
113. D. Cohen, J. A. Dickerson, C. D. Whitmore, E. H. Turner, M. M. Palcic, O. Hindsgaul, and N. J. Dovichi, *Annual Review of Analytical Chemistry* **1**, 165 (2008).
114. R. H. Templer and O. Ces, *Journal of the Royal Society Interface* **5**, S111 (2008).
115. J. A. Jankowski, S. Tracht, and J. V. Sweedler, *Trac-trends In Analytical Chemistry* **14**, 170 (1995).
116. D. L. Taylor, E. S. Woo, and K. A. Giuliano, *Current Opinion In Biotechnology* **12**, 75 (2001).
117. T. C. Chao and A. Ros, *Journal of the Royal Society Interface* **5**, S139 (2008).
118. L. M. Borland, S. Kotegoda, K. S. Phillips, and N. L. Allbritton, *Annual Review of Analytical Chemistry* **1**, 191 (2008).
119. E. Oh, M. N. Hasan, M. Jamshed, S. H. Park, H. M. Hong, E. J. Song, and Y. S. Yoo, *Electrophoresis* **31**, 74 (2010).
120. K. G. H. Janssen, J. C. T. Eijkel, T. N. R., L. J. de Vreede, T. Hankemeier, and H. J. van der Linden, in *μ Tas 2011* (2011).

121. G. Nouadje, H. Rubie, E. Chatelut, P. Canal, M. Nertz, P. Puig, and F. Couderc, *Journal of Chromatography A* **717**, 293 (1995).
122. M. Du, V. Flanigan, and Y. F. Ma, *Electrophoresis* **25**, 1496 (2004).
123. C. S. Effenhauser, A. Manz, and H. M. Widmer, *Analytical Chemistry* **65**, 2637 (1993).
124. Y. Chen, L. J. Xu, L. Zhang, and G. N. Chen, *Analytical Biochemistry* **380**, 297 (2008).
125. M. Mamunooru, R. J. Jenkins, N. I. Davis, and J. G. Shackman, *Journal of Chromatography A* **1202**, 203 (2008).
126. Y. Chen, L. Zhang, L. J. Xu, J. M. Lin, and G. N. Chen, *Electrophoresis* **30**, 2300 (2009).
127. N. I. Davis, M. Mamunooru, C. A. Vyas, and J. G. Shackman, *Analytical Chemistry* **81**, 5452 (2009).
128. M. Pumera, *Electrophoresis* **28**, 2113 (2007).
129. N. J. Reinhoud, U. R. Tjaden, and J. Van der Greef, *Journal of Chromatography A* **673**, 239 (1994).
130. K. G. H. Janssen, J. Li, H. T. Hoang, P. Vulto, R. J. B. H. N. van den Berg, H. S. Overkleeft, J. C. T. Eijkel, N. R. Tas, H. J. van der Linden, and T. Hankemeier, *Lab On A Chip* **12**, 2888 (2012).
131. S. M. Kenyon, M. M. Meighan, and M. A. Hayes, *Electrophoresis* **32**, 482 (2011).
132. D. Kaniansky, M. Masár, J. Bielčíková, F. Iványi, F. Eisenbeiss, B. Stanislawska, B. Grass, A. Neyer, and M. Jöhnck, *Analytical Chemistry* **72**, 3596 (2000).
133. D. Bottenus, T. Z. Jubery, Y. X. Ouyang, W. J. Dong, P. Dutta, and C. F. Ivory, *Lab on a Chip* **11**, 890 (2011).
134. D. Bottenus, T. Z. Jubery, P. Dutta, and C. F. Ivory, *Electrophoresis* **32**, 550 (2011).
135. J. Wang, Y. Zhang, M. R. Mohamadi, N. Kaji, M. Tokeshi, and Y. Baba, *Electrophoresis* **30**, 3250 (2009).
136. J. E. Prest, M. S. Beardah, S. J. Baldock, S. P. Doyle, P. R. Fielden, N. J. Goddard, and B. J. T. Brown, *Journal of Chromatography A* **1195**, 157 (2008).
137. H. Huang, F. Xu, Z. Dai, and B. Lin, *Electrophoresis* **26**, 2254 (2005).
138. D. Liu, Z. Ou, M. Xu, and L. Wang, *Journal of Chromatography A* **1214**, 165 (2008).
139. D. Liu, M. Shi, H. Huang, Z. Long, X. Zhou, J. Qin, and B. Lin, *Journal of Chromatography B* **844**, 32 (2006).
140. A. Persat, L. A. Marshall, and J. G. Santiago, *Analytical Chemistry* **81**, 9507 (2009).
141. R. B. Schoch, M. Ronaghi, and J. G. Santiago, *Lab On A Chip* **9**, 2145 (2009).
142. A. Persat and J. G. Santiago, *Analytical Chemistry* **83**, 2310 (2011).
143. M. Bercovici, G. V. Kaigala, K. E. Mach, C. M. Han, J. C. Liao, and J. G.

- Santiago, Analytical Chemistry **83**, 4110 (2011).
144. G. V. Kaigala, M. Bercovici, M. Behnam, D. Elliott, J. G. Santiago, and C. J. Backhouse, Lab on a Chip **10**, 2242 (2010).
145. F. E. Ahmed, Journal of Chromatography B **877**, 1963 (2009).
146. A. García-Campaña, L. Gámiz-Gracia, F. Lara, M. del Olmo Iruela, and C. Cruces-Blanco, Analytical and Bioanalytical Chemistry **395**, 967 (2009).
147. L. Suntornsuk, Analytical and Bioanalytical Chemistry **398**, 29 (2010).
148. M. Urbánek, A. Varenne, P. Gebauer, L. Křivánková, and P. Gareil, Electrophoresis **27**, 4859 (2006).
149. G. I. Abelev and E. R. Karamova, Molecular Immunology **26**, 41 (1989).
150. M. C. Breadmore and J. P. Quirino, Analytical Chemistry **80**, 6373 (2008).
151. M. C. Breadmore, Electrophoresis **29**, 1082 (2008).
152. M. C. Breadmore, Journal of Chromatography A **1217**, 3900 (2010).
153. S. M. Kim, M. A. Burns, and E. F. Hasselbrink, Analytical Chemistry **78**, 4779 (2006).
154. S. R. Park and H. Swerdlow, Analytical Chemistry **75**, 4467 (2003).
155. J. Astorga-Wells, S. Vollmer, S. Tryggvason, T. Bergman, and H. Jörnvall, Analytical Chemistry **77**, 7131 (2005).
156. A. Plecis, R. B. Schoch, and P. Renaud, Nano Letters **5**, 1147 (2005).
157. T. A. Zangle, A. Mani, and J. G. Santiago, Analytical Chemistry **82**, 3114 (2010).
158. K. Zhou, M. L. Kovarik, and S. C. Jacobson, Journal of the American Chemical Society **130**, 8614 (2008).
159. D. Wu and A. J. Steckl, Lab on a Chip **9**, 1890 (2009).
160. B. Scarff, C. Escobedo, and D. Sinton, Lab on a Chip **11**, 1102 (2011).
161. X. Mao, B. R. Reschke, and A. T. Timperman, Electrophoresis **31**, 2686 (2010).
162. H. Yu, Y. Lu, Y.-g. Zhou, F.-b. Wang, F.-y. He, and X.-h. Xia, Lab On A Chip **8**, 1496 (2008).
163. K.-D. Huang and R.-J. Yang, Electrophoresis **29**, 4862 (2008).
164. Y.-C. Wang and J. Han, Lab on a Chip **8**, 392 (2008).
165. L. F. Cheow, S. H. Ko, S. J. Kim, K. H. Kang, and J. Han, Analytical Chemistry **82**, 3383 (2010).
166. J. Lee and J. Han, Microfluidics and Nanofluidics **9**, 973 (2010).
167. J. H. Lee, Y.-A. Song, S. R. Tannenbaum, and J. Han, Analytical Chemistry **80**, 3198 (2008).
168. J. H. Lee, B. D. Cosgrove, D. A. Lauffenburger, and J. Han, Journal of the American Chemical Society **131**, 10340 (2009).
169. A. Sarkar and J. Han, Lab on a Chip **11**, 2569 (2011).
170. J. H. Lee, Y.-A. Song, and J. Han, Lab on a Chip **8**, 596 (2008).
171. S. H. Ko, S. J. Kim, L. F. Cheow, L. D. Li, K. H. Kang, and J. Han, Lab on a Chip **11**, 1351 (2011).
172. S. J. Kim, S. H. Ko, K. H. Kang, and J. Han, Nat Nano **5**, 297 (2010).
173. S. J. Kim, L. D. Li, and J. Han, Langmuir **25**, 7759 (2009).

174. J. Quist, K. G. H. Janssen, P. Vulto, T. Hankemeier, and H. J. van der Linden, *Analytical Chemistry* **83**, 7910 (2011).
175. X. Lu, M. Rycenga, S. E. Skrabalak, B. Wiley, and Y. Xia, *Annual Review of Physical Chemistry* **60**, 167 (2009).
176. E. C. Le Ru and E. P. G., *Principles of Surface-Enhanced Raman Spectroscopy, and related plasmonic effects* (Elsevier B.V. Amsterdam, 2009).
177. Z. J. Wang, S. L. Pan, T. D. Krauss, H. Du, and L. J. Rothberg, *Proceedings of the National Academy of Sciences of the United States of America* **100**, 8638 (2003).
178. K. Kneipp, M. Moskovits, and K. H., *Surface-Enhanced Raman Scattering, Physics and Applications* (Springer-Verlag Berlin Heidelberg, 2006).
179. P. L. Stiles, J. A. Dieringer, N. C. Shah, and R. R. Van Duyne, *Annual Review of Analytical Chemistry* **1**, 601 (2008).
180. J. P. Camden, J. A. Dieringer, Y. M. Wang, D. J. Masiello, L. D. Marks, G. C. Schatz, and R. P. Van Duyne, *Journal of the American Chemical Society* **130**, 12616 (2008).
181. S. J. Lee, Z. Q. Guan, H. X. Xu, and M. Moskovits, *Journal of Physical Chemistry C* **111**, 17985 (2007).
182. J. Kneipp, H. Kneipp, and K. Kneipp, *Chemical Society Reviews* **37**, 1052 (2008).
183. J. N. Anker, W. P. Hall, O. Lyandres, N. C. Shah, J. Zhao, and R. P. Van Duyne, *Nature Materials* **7**, 442 (2008).
184. S. Abalde-Cela, P. Aldeanueva-Potel, C. Mateo-Mateo, L. Rodriguez-Lorenzo, R. A. Alvarez-Puebla, and L. M. Liz-Marzan, *Journal of the Royal Society Interface* **7**, S435 (2010).
185. K. C. Bantz, A. F. Meyer, N. J. Wittenberg, H. Im, O. Kurtulus, S. H. Lee, N. C. Lindquist, S. H. Oh, and C. L. Haynes, *Physical Chemistry Chemical Physics* **13**, 11551 (2011).
186. R. Dijkstra, Ph.D. thesis, Vrije Universiteit Amsterdam (2004).
187. P. W. Atkins, *Physical Chemistry* (Oxford University Press, 1998).
188. R. A. Alvarez-Puebla, E. Arceo, P. J. G. Goulet, J. J. Garrido, and R. F. Aroca, *Journal of Physical Chemistry B* **109**, 3787 (2005).
189. J. Workman, M. Koch, B. Lavine, and R. Chrisman, *Analytical Chemistry* **81**, 4623 (2009).
190. L. O. Brown and S. K. Doorn, *Langmuir* **24**, 2178 (2008).
191. B. G. Prevo, D. M. Kuncicky, and O. D. Velev, *Colloids and Surfaces A-physicochemical and Engineering Aspects* **311**, 2 (2007).
192. P. Jiang, C. H. Sun, N. C. Linn, B. J. Ho, and S. Venkatesh, *Current Nanoscience* **3**, 296 (2007).
193. T. Qiu, X. L. Wu, J. C. Shen, and P. K. Chu, *Applied Physics Letters* **89**, 131914 (2006).
194. R. G. Freeman, K. C. Grabar, K. J. Allison, R. M. Bright, J. A. Davis, A. P. Guthrie, M. B. Hommer, M. A. Jackson, P. C. Smith, D. G. Walter,, *Science* **267**, 1629 (1995).

195. S. H. Park, J. H. Im, J. W. Im, B. H. Chun, and J. H. Kim, *Microchemical Journal* **63**, Korean Chem Soc, Analyt Chem Div (1999).
196. T. Karakouz, A. Vaskevich, and I. Rubinstein, *Journal of Physical Chemistry B* **112**, 14530 (2008).
197. S. Karabacak, M. Kaya, T. Vo-Dinh, and M. Volkan, *Journal of Nanoscience and Nanotechnology* **8**, 955 (2008).
198. X. F. Liu, C. H. Sun, N. C. Linn, B. Jiang, and P. Jiang, *Journal of Physical Chemistry C* **113**, 14804 (2009).
199. A. Jamshidi, S. L. Neale, K. Yu, P. J. Pauzauskie, P. J. Schuck, J. K. Valley, H. Y. Hsu, A. T. Ohta, and M. C. Wu, *Nano Letters* **9**, 2921 (2009).
200. K. A. Willets and R. P. Van Duyne, *Annual Review of Physical Chemistry* **58**, 267 (2007).
201. D. Millo, A. Bonifacio, A. Ranieri, M. Borsari, C. Gooijer, and G. van der Zwan, *Langmuir* **23**, 4340 (2007).
202. J. J. Feng, U. Gernert, M. Sezer, U. Kuhlmann, D. H. Murgida, C. David, M. Richter, A. Knorr, P. Hildebrandt, and I. M. Weidinger, *Nano Letters* **9**, 298 (2009).
203. J. Henzie, J. Lee, M. H. Lee, W. Hasan, and T. W. Odom, *Annual Review of Physical Chemistry* **60**, 147 (2009).
204. G. Das, F. Mecarini, F. de Angelis, M. Prasciolu, C. Liberale, M. Patrini, and E. Di Fabrizio, *Microelectronic Engineering* **85**, 1282 (2008).
205. J. D. Driskell, S. Shanmukh, Y. J. Liu, S. Hennigan, L. Jones, Y. P. Zhao, R. A. Dluhy, D. C. Krause, and R. A. Tripp, *Ieee Sensors Journal* **8**, 863 (2008).
206. J. G. Fan and Y. P. Zhao, *Langmuir* **24**, 14172 (2008).
207. H. Cho, B. Lee, G. L. Liu, A. Agarwal, and L. P. Lee, *Lab on a Chip* **9**, 3360 (2009).
208. J. M. Baik, S. J. Lee, and M. Moskovits, *Nano Letters* **9**, 672 (2009).
209. N. M. B. Perney, F. J. G. de Abajo, J. J. Baumberg, A. Tang, M. C. Netti, M. D. B. Charlton, and M. E. Zoorob, *Physical Review B* **76**, 035426 (2007).
210. R. E. Holmlin, X. X. Chen, R. G. Chapman, S. Takayama, and G. M. Whitesides, *Langmuir* **17**, 2841 (2001).
211. C. D. Heyes, J. Groll, M. Moller, and G. U. Nienhaus, *Molecular Biosystems* **3**, 419 (2007).
212. R. Narayanan, R. J. Lipert, and M. D. Porter, *Analytical Chemistry* **80**, 2265 (2008).
213. K. Ryu, A. J. Haes, H.-Y. Park, S. Nah, J. Kim, H. Chung, M.-Y. Yoon, and S.-H. Han, *Journal of Raman Spectroscopy* **41**, 121 (2010).
214. B. J. Kennedy, S. Spaeth, M. Dickey, and K. T. Carron, *Journal of Physical Chemistry B* **103**, 3640 (1999).
215. K. T. Carron and B. J. Kennedy, *Analytical Chemistry* **67**, 3353 (1995).
216. B. J. Kennedy, R. Milofsky, and K. T. Carron, *Analytical Chemistry* **69**, 4708 (1997).
217. K. T. Carron, K. Mullen, M. Lanouette, and H. Angersbach, *Applied Spec-*

- troscopy **45**, 420 (1991).
218. K. I. Mullen, D. X. Wang, L. G. Crane, and K. T. Carron, Analytical Chemistry **64**, 930 (1992).
219. J. K. Lim and S. W. Joo, Applied Spectroscopy **60**, 847 (2006).
220. X. M. Qian, J. Li, and S. M. Nie, Journal of the American Chemical Society **131**, 7540 (2009).
221. N. C. Shah, O. Lyandres, J. T. Walsh, M. R. Glucksberg, and R. P. Van Duyne, Analytical Chemistry **79**, 6927 (2007).
222. M. H. Harpster, H. Zhang, A. K. Sankara-Warrier, B. H. Ray, T. R. Ward, J. P. Kollmar, K. T. Carron, J. O. Mecham, R. C. Corcoran, W. C. Wilson,, Biosensors & Bioelectronics **25**, 674 (2009).
223. D. A. Stuart, J. M. Yuen, N. S. O. Lyandres, C. R. Yonzon, M. R. Glucksberg, J. T. Walsh, and R. P. Van Duyne, Analytical Chemistry **78**, 7211 (2006).
224. C. E. Talley, L. Jusinski, C. W. Hollars, S. M. Lane, and T. Huser, Analytical Chemistry **76**, 7064 (2004).
225. S. Zong, Z. Wang, J. Yang, and Y. Cui, Analytical Chemistry **83**, 4178 (2011).
226. J. P. Scaffidi, M. K. Gregas, V. Seewaldt, and T. Vo-Dinh, Analytical and Bioanalytical Chemistry **393**, 1135 (2009).
227. W. Xie, L. Su, A. Shen, A. Materny, and J. Hu, Journal of Raman Spectroscopy **42**, 1248 (2011).
228. D. L. Stokes, Z. H. Chi, and T. Vo-Dinh, Applied Spectroscopy **58**, 292 (2004).
229. K. L. Prime and G. M. Whitesides, Science **252**, 1164 (1991).
230. C. S. Weisbecker, M. V. Merritt, and G. M. Whitesides, Langmuir **12**, 3763 (1996).
231. J. Rundqvist, J. H. Hoh, and D. B. Haviland, Journal of Colloid and Interface Science **301**, 337 (2006).
232. D. J. Vanderah, M. L. Walker, M. A. Rocco, and K. A. Rubinson, Langmuir **24**, 826 (2008).
233. X. M. Qian, X. H. Peng, D. O. Ansari, Q. Yin-Goen, G. Z. Chen, D. M. Shin, L. Yang, A. N. Young, M. D. Wang, and S. M. Nie, Nature Biotechnology **26**, 83 (2008).
234. A. Shkilnyy, M. Souce, P. Dubois, F. Warmont, M.-L. Saboungi, and I. Chourpa, Analyst **134**, 1868 (2009).
235. N. Papen-Botterhuis, Ph.D. thesis, Technische Universiteit Eindhoven (2008).
236. A. Królikowska and J. Bukowska, Journal of Raman Spectroscopy **38**, 936 (2007).
237. P. C. Lee and D. Meisel, Journal of Physical Chemistry **86**, 3391 (1982).
238. A. Rodes, M. Rueda, F. Prieto, C. Prado, J. M. Feliu, and A. Aldaz, Journal of Physical Chemistry C **113**, 18784 (2009).
239. H. E. Bennett, R. L. Peck, D. K. Burge, and J. M. Bennett, Journal of Applied Physics **40**, 3351 (1969).
240. Y. Han, R. Lupitskyy, T.-M. Chou, C. M. Stafford, H. Du, and S. Sukhishvili,

- Analytical Chemistry **83**, 5873 (2011).
- 241. C. Caro, C. López-Cartes, P. Zaderenko, and J. A. Mejías, Journal of Raman Spectroscopy **39**, 1162 (2008).
 - 242. M. B. Andersen, J. Frey, S. Pennathur, and H. Bruus, Journal of Colloid and Interface Science **353**, 301 (2011).
 - 243. W. Piasecki and R. Charmas, Adsorption-journal of the International Adsorption Society **19**, 653 (2013).
 - 244. R. B. H. Veenhuis, E. J. van der Wouden, J. W. van Nieuwkastele, A. van den Berg, and J. C. T. Eijkel, Lab On A Chip **9**, 3472 (2009).
 - 245. S. M. Stavis, E. A. Strychalski, and M. Gaitan, Nanotechnology **20**, 165302 (2009).
 - 246. J. Luo and Y. Wan, Journal of Membrane Science **438**, 18 (2013).
 - 247. S. S. Bahga, M. Bercovici, and J. G. Santiago, Electrophoresis **33**, 3036 (2012).
 - 248. M. T. Blom, N. R. Tas, G. Pandraud, E. Chmela, J. G. E. Gardeniers, R. Tijsse, M. Elwenspoek, and A. van den Berg, Journal of Microelectromechanical Systems **10**, 158 (2001).
 - 249. J. Quist, P. Vulto, H. van der Linden, and T. Hankemeier, Analytical Chemistry **84**, 9065 (2012).
 - 250. J. Stichlmair, J. Schmidt, and R. Propesch, Chemical Engineering Science **47**, 3015 (1992).
 - 251. K. M. van Delft, J. C. T. Eijkel, D. Mijatovic, T. S. Druzhinina, H. Rathgen, N. R. Tas, A. van den Berg, and F. Mugele, Nano Letters **7**, 345 (2007).
 - 252. J. Emmelkamp, Ph.D. thesis, Twente University of Technology, Enschede (2007).

