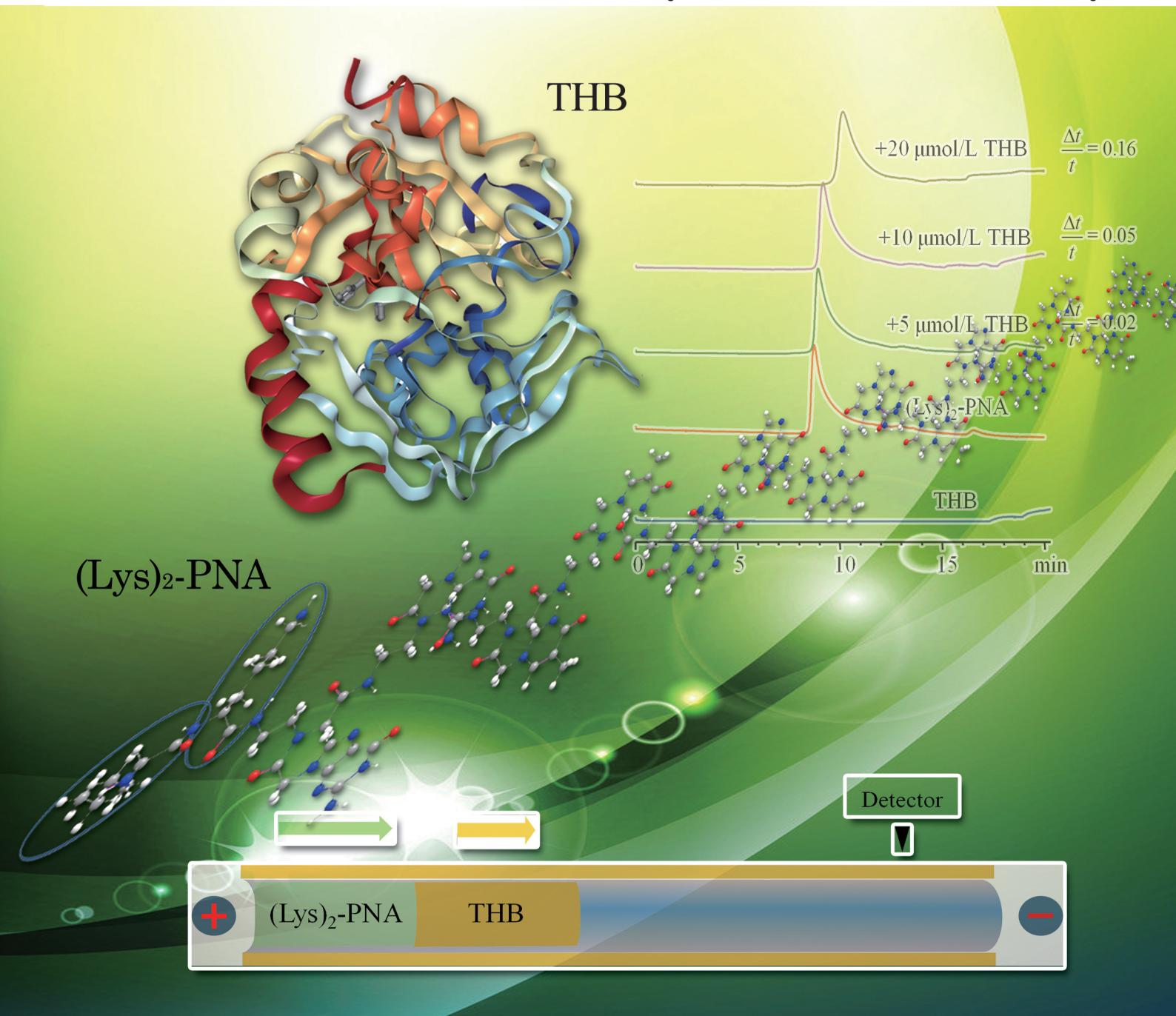
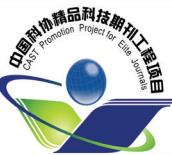


# CJAC Chinese Journal of Analytical Chemistry



Sponsored by

the Chinese Chemical Society  
the Chinese Academy of Sciences  
<http://www.analchem.cn> E-mail: fxhx@ciac.ac.cn



# 分析化学

第46卷 第12期 2018年12月

## 目 次

### 评述与进展

- 循环肿瘤细胞富集技术研究进展 ..... 董建伟 夏凌\* 李攻科\* (1851)  
★模块化微流控系统与应用 ..... 范一强\* 王洪亮 高克鑫 刘竞技 柴东平 张亚军 (1863)

### 仪器装置与实验技术

- ★多边形电极线形离子阱质量分析器的结构与性能 ..... 孙露露 许崇晟 徐福兴 周振 丁传凡\* (1872)  
★基于数字微镜器件的原子荧光色散检测技术研究 ..... 陶琛 李春生\* 王宏霞 张雅茹 赵成威 周志恒 马振予 田地\* (1878)

### 研究报告

- 基于3-巯基丙磺酸膜修饰金电极无线传感检测汞离子 ..... 肖情 陈琳 李文锋 杨丽琴 曹忠\* 于鑫垚 龙姝 何婧琳 肖忠良\* (1886)  
★毛细管柱上反应研究氨基酸修饰肽核酸与蛋白质的相互作用 ..... 王晓倩 Ghulam Murtaza 朱超 屈锋\* (1895)  
构建金纳米粒子标记的凝集素芯片应用于抗生素与金黄色葡萄球菌相互作用研究 ..... 李铸衡 高晶清 简明红 王振新\* (1904)  
二氧化钛纳米线阵列富集与内部萃取电喷雾电离质谱联用检测大豆磷脂 ..... 寇伟 张华 卢海艳 朱丽雪 刘爱英 黄科科\* 陈焕文\* (1913)  
基于离子液体的基质辅助激光解吸电离质谱成像分析桑叶表面和叶脉切片中的小分子成分 ..... 刘晓宁 裴兴丽 龚灿 许旭\* (1923)  
基于二硫化钼/多孔石墨烯复合材料的木犀草素电化学传感器 ..... 许冰洁 席佳佳 冯莹莹 赵发琼 曾百肇\* (1931)  
检测Al<sup>3+</sup>的席夫碱荧光探针的合成和性能研究 ..... 王宇斌 侯玲杰 葛金印 双少敏\* (1937)  
基于双重脱氧核酶的超灵敏比色法检测铜离子 ..... 梅晓宏 田晶晶 张洋子 杜再慧 张媛 许文涛\* (1945)  
★一种用于抗体快速分离的嗜硫纳米粒子的制备及表征 ..... 程昉\* 冯前程 何炜 赵鲜明 汪晴 (1953)  
二氧化钛纳米管阵列/钛pH电极制备与表征 ..... 李振 刘寒蒙 姚志霞 孙玉静\* 李壮\* (1961)  
微波辐照快速合成Pd/石墨烯纳米复合材料及其对甲醇氧化的电催化性能 ..... 杨木泉 张旋 颜悦\* (1968)  
金负载木基顶空固相微萃取-热脱附原子吸收光谱法快速测定水中汞 ..... 马旭 张芳 潘佳钏 郭鹏然\* 欧阳钢锋\* (1975)

静电纺丝法制备氧化锆纳米纤维修饰玻碳电极用于甲基对硫磷的检测

..... 于皓 万正妍 朱国栋 戴勇 王彦博 刘建允\* (1982)

三聚氰胺/邻苯二甲醛共价有机骨架材料结合固相萃取-液相色谱串联质谱检测环境水样中

痕量磺胺类抗生素 ..... 王欣梅 徐桂菊 王晓利\* 王霞 王明林\* 赵汝松 林金明 (1990)

以杆菌肽为模板的金簇制备及其在腺嘌呤核苷三磷酸检测中的应用

..... 阮胜利 张婷婷 张敏\* 章弘扬 王月荣 胡坪\* (1997)

顶空-固相微萃取-全二维气相色谱-飞行时间质谱测定水中短链氯化石蜡

..... 战楠 朱帅 郭峰 田芹 饶竹\* (2004)

微波辅助水蒸汽结合上浮溶剂固化法快速萃取谷物中三嗪类除草剂 ..... 李桂杰 王大为\* 丁兰\* (2011)

同位素稀释-气相色谱串联质谱法测定饲料中指示性多氯联苯

..... 王瑞国 张苏 董姝君 魏书林 张天妹 杨浩森 程劼 王培龙 苏晓鸥\* (2019)

## 企业消息

IKA 产品 T25 easy clean 分散机荣获 2019 德国设计奖——T25 easy clean 分散机荣获“工业类特别提名”奖项(1871)、院  
网络科学传播平台—中国科普博览约稿函(1912, 1981)、安东帕 Anton Paar 微波消解解决方案让金属杂质无处遁形  
(1974, 2003)

## 书刊征订

《理化检验——化学分册》(1967)

## 广告目录

中国科学计量研究院(封二) 岛津国际贸易(上海)有限公司(文前 1) 岛津国际贸易(上海)有限公司(文前 2) 赛  
默飞世尔科技(中国)有限公司(文前 3) 大连大特气体有限公司(文前 4) 青岛盛瀚色谱技术有限公司(文前 5) 德  
国耶拿分析仪器有限公司(文前 6) 青岛普仁仪器有限公司(文前 7) 第 17 届北京科学仪器及实验室装备展览会(文  
前 8) 分析化学宣传广告(文前 9) 安东帕(上海)商贸有限公司(目录对) 瑞士万通中国有限公司(文中 1) 钢研  
纳克检测技术股份有限公司(文中 2) 北京海光仪器公司(封三) phenomenex(天津博纳艾杰尔科技有限公司)  
(封底)

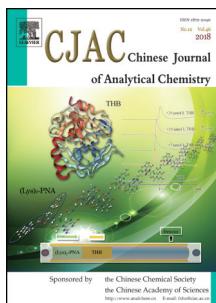
(本期责任编辑：于桂红 编排：潘文革)

---

\* 通讯联系人

★ 该篇文章的英文电子版由 Elsevier 出版社在 ScienceDirect 上出版 (<http://www.sciencedirect.com/journal/chinese-journal-of-analytical-chemistry>)

万方数据



On page 1895 – 1903, Wang et al developed a capillary electrophoresis online reaction method for interaction study of three proteins with lysine or glutamic acid modified peptide nucleic acids (PNA). The method was simple to operate with minimum cost, and suitable for assess the interaction of proteins.

## CONTENTS

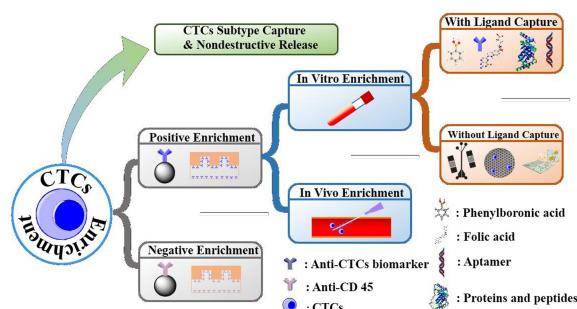
Vol. 46 No. 12 (1851–2024) December 2018

### Review and Progress

#### Progress in Enrichment Techniques of Circulating Tumor Cells

DONG Jian-Wei, XIA Ling\*, LI Gong-Ke\*

Chinese J. Anal. Chem., 2018, 46(12): 1851–1862



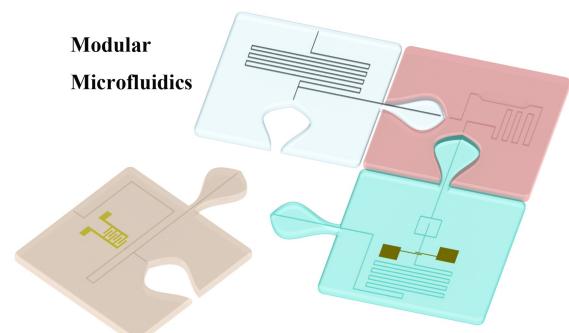
### ★ Applications of Modular Microfluidics Technology

FAN Yi-Qiang\*, WANG Hong-Liang,

GAO Ke-Xin, LIU Jing-Ji, CHAI Dong-Ping,

ZHANG Ya-Jun

Chinese J. Anal. Chem., 2018, 46(12): 1863–1871



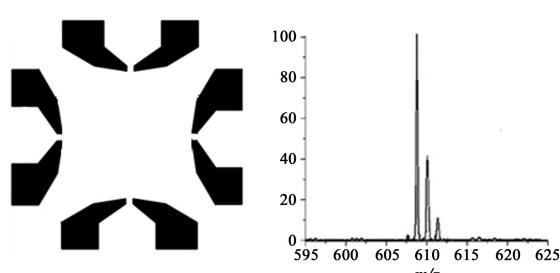
### Experimental Technique and Instrument

#### ★ Structure and Performance of Polygonal Electrode Linear Ion Trap

SUN Lu-Lu, XU Chong-Sheng, XU Fu-Xing,

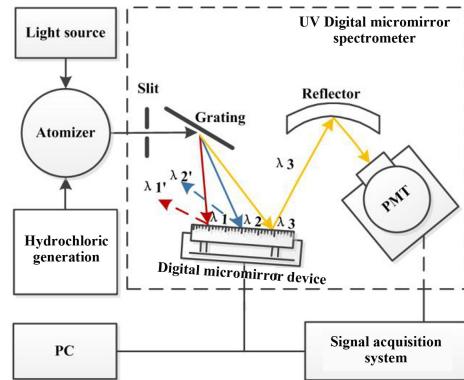
ZHOU Zhen, DING Chuan-Fan\*

Chinese J. Anal. Chem., 2018, 46(12): 1872–1877



★ Research on Dispersive Detection Technology Based on Digital Micromirror Device by Atomic Fluorescence Spectrometry

TAO Chen, LI Chun-Sheng\*, WANG Hong-Xia, ZHANG Ya-Ru, ZHAO Cheng-Wei, ZHOU Zhi-Heng, MA Zhen-Yu, TIAN Di\*  
*Chinese J. Anal. Chem.*, 2018, 46(12) : 1878–1885

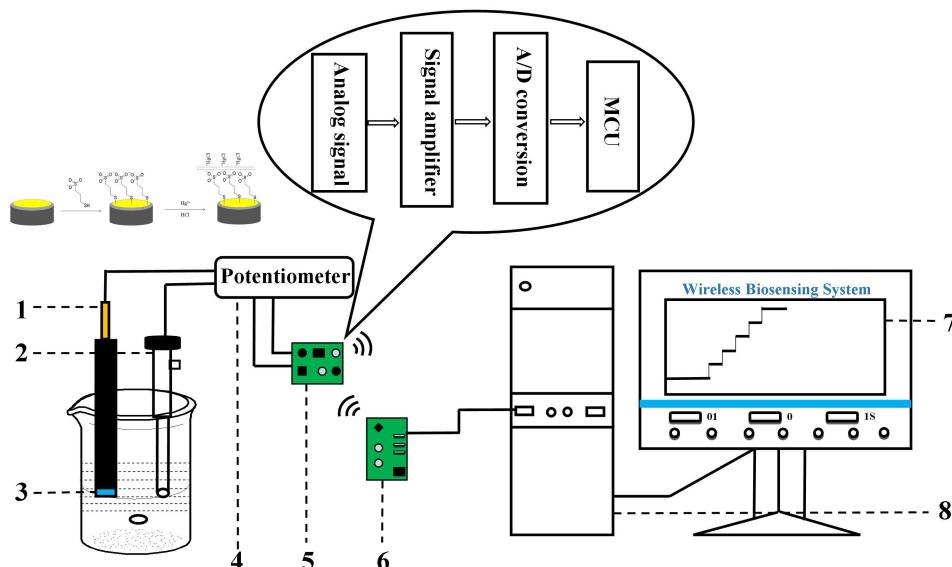


Scientific Papers

**A Wireless Sensor Based on 3-Mercaptopropyl Sulfonic Acid Membrane Modified Gold Electrode for Detection of  $Hg^{2+}$**

XIAO Qing, CHEN Lin, LI Wen-Feng, YANG Li-Qin, CAO Zhong\*, YU Xin-Yao, LONG Shu, HE Jing-Lin, XIAO Zhong-Liang\*

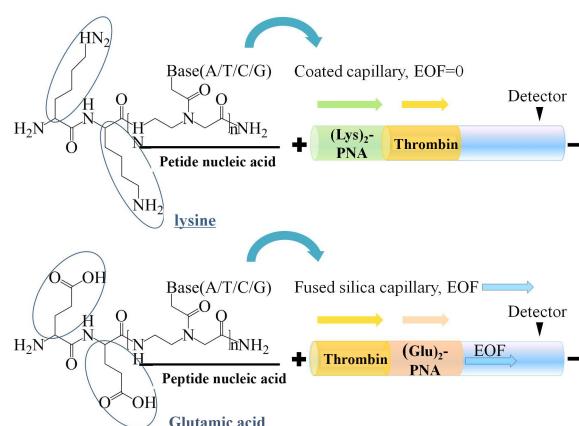
*Chinese J. Anal. Chem.*, 2018, 46(12) : 1886–1894



★ Online Capillary Electrophoresis Reaction for Interaction Study of Amino Acid Modified Peptide Nucleic Acid and Proteins

WANG Xiao-Qian, Ghulam Murtaza, ZHU Chao, QU Feng\*

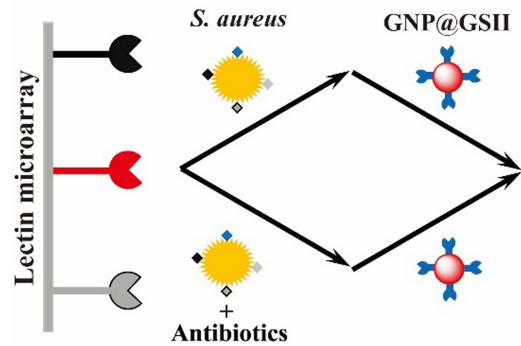
*Chinese J. Anal. Chem.*, 2018, 46(12) : 1895–1903



## Fabrication of Lectin Microarray for Studying Interactions of Antibiotics with *Staphylococcus aureus* by Gold Nanoparticle Probes

LI Zhu-Heng, GAO Jing-Qing, JIAN Ming-Hong,  
WANG Zhen-Xin \*

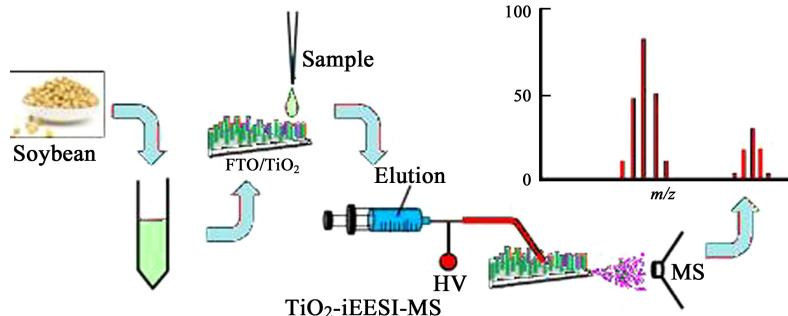
Chinese J. Anal. Chem. , 2018 , 46(12) : 1904–1912



## Determination of Phospholipids in Soybean by Titanium Dioxide Nanowires Array Enrichment Combined with Internal Extractive Electrospray Ionization Mass Spectrometry

KOU Wei, ZHANG Hua, LU Hai-Yan, ZHU Li-Xue, LIU Ai-Ying, HUANG Ke-Ke \* ,  
CHEN Huan-Wen \*

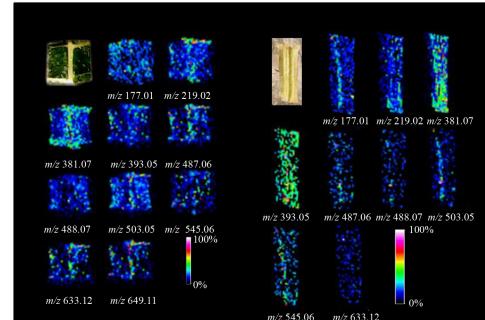
Chinese J. Anal. Chem. , 2018 , 46(12) : 1913–1922



## Matrix-assisted Laser Desorption Ionization-Mass Spectrometry Imaging of Small Molecules in Mulberry Leaf Using Ionic Liquid as Matrix

LIU Xiao-Ning, PEI Xing-Li, GONG Can ,  
XU Xu \*

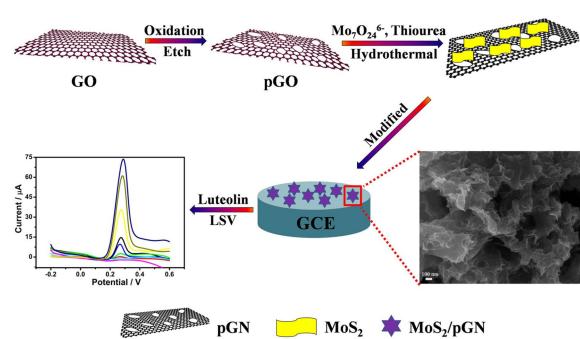
Chinese J. Anal. Chem. , 2018 , 46(12) : 1923–1930



## Molybdenum Disulfide/Porous Graphene Composite-based Electrochemical Sensor for Detection of Luteolin

XU Bing-Jie , XI Jia-Jia , FENG Ying-Ying ,  
ZHAO Fa-Qiong , ZENG Bai-Zhao \*

Chinese J. Anal. Chem. , 2018 , 46(12) : 1931–1936

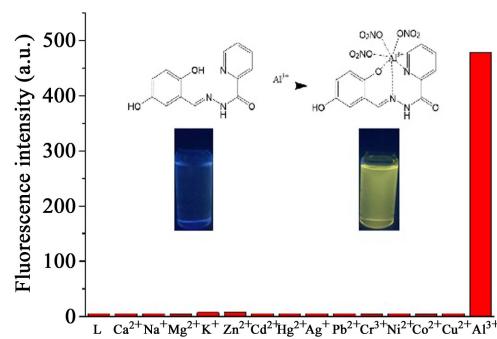


## A Novel Schiff Base Fluorescent Probe for

Determination of Al<sup>3+</sup>

WANG Yu-Bin, HOU Ling-Jie, GE Jin-Yin,  
SHUANG Shao-Min\*

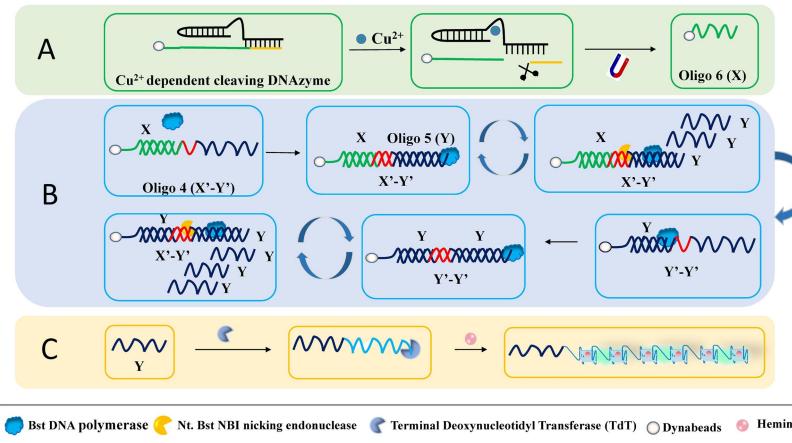
Chinese J. Anal. Chem., 2018, 46(12) : 1937–1944



## Ultrasensitive and Colorimetric Detection of Copper(II) Based on Dual-DNAzymes

MEI Xiao-Hong, TIAN Jing-Jing, ZHANG Yang-Zi, DU Zai-Hui, ZHANG Yuan, XU Wen-Tao\*

Chinese J. Anal. Chem., 2018, 46(12) : 1945–1952

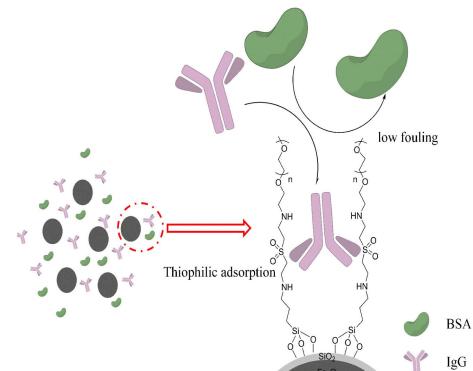


## ★ Preparation and Characterization of

PEGylated Thiophilic Nanoparticles for Rapid Antibody Separation

CHENG Fang\*, FENG Qian-Cheng, HE Wei,  
ZHAO Xian-Ming, WANG Qing

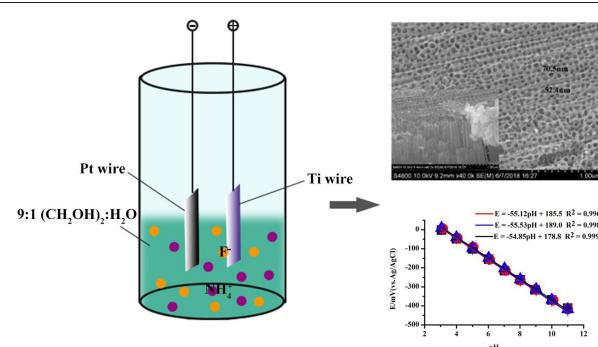
Chinese J. Anal. Chem., 2018, 46(12) : 1953–1960



## Preparation and Characterization of Titanium Dioxide Nanotube Array/Titanium pH Electrode

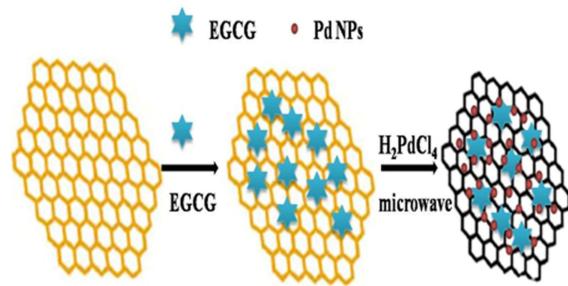
LI Zhen, LIU Han-Meng, YAO Zhi-Xia,  
SUN Yu-Jing\*, LI Zhuang\*

Chinese J. Anal. Chem., 2018, 46(12) : 1961–1967



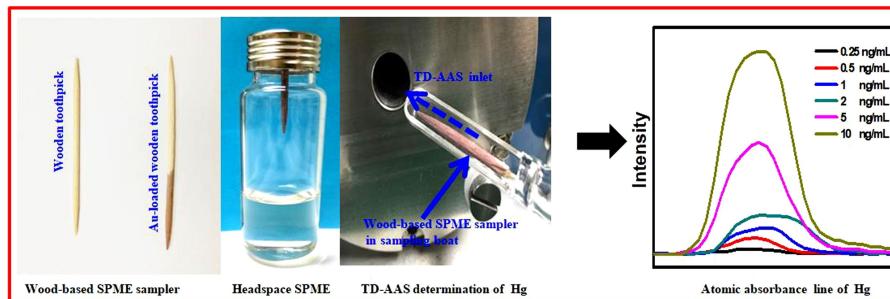
**Rapid Synthesis of Palladium/Graphene Nanocomposites via Microwave Irradiation and Their Electrocatalytic Oxidation of Methanol**

YANG Mu-Quan, ZHANG Xuan, YAN Yue \*  
Chinese J. Anal. Chem., 2018, 46(12) : 1968–1974



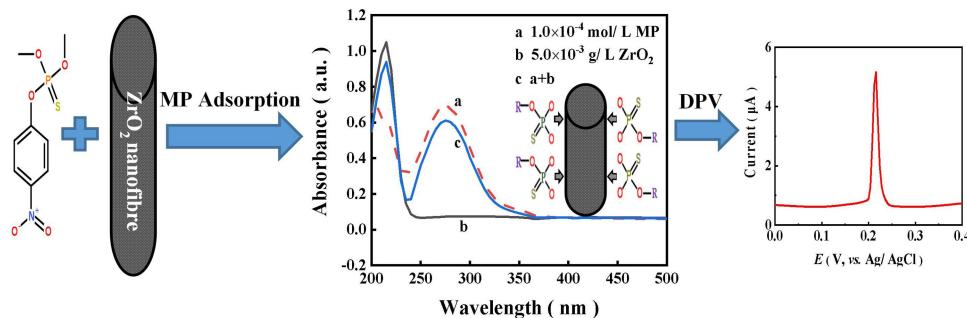
**Detection of Mercury in Environmental Water by Thermal Desorption-Atomic Absorption Spectrometry Coupled with Gold-immobilized Wood Based Solid Phase Microextraction**

MA Xu, ZHANG Fang, PAN Jia-Chuan, GUO Peng-Ran \*, OUYANG Gang-Feng \*  
Chinese J. Anal. Chem., 2018, 46(12) : 1975–1981



**Electrospun Zirconia Nanofibre-modified Glassy Carbon Electrode for Determination of Methyl Parathion**

YU Hao, WAN Zheng-Yan, ZHU Guo-Dong, DAI Yong, WANG Yan-Bo, LIU Jian-Yun \*  
Chinese J. Anal. Chem., 2018, 46(12) : 1982–1989

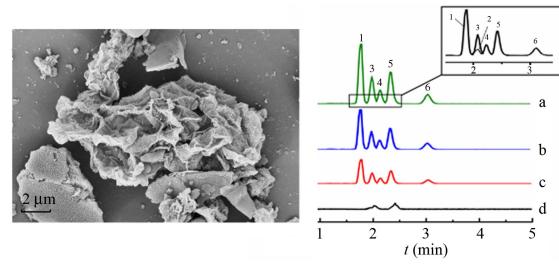


**Melamine/o-Phthalaldehyde Covalent Organic Frameworks for Solid Phase Extraction-Liquid Chromatography-Tandem Mass Spectrometry Analysis of Sulfonamide Antibiotics in Environmental Samples**

WANG Xin-Mei, XU Gui-Ju, WANG Xiao-Li \*, WANG Xia, WANG Ming-Lin \*, ZHAO Ru-Song, LIN Jin-Ming

Chinese J. Anal. Chem., 2018, 46(12) : 1990–1996

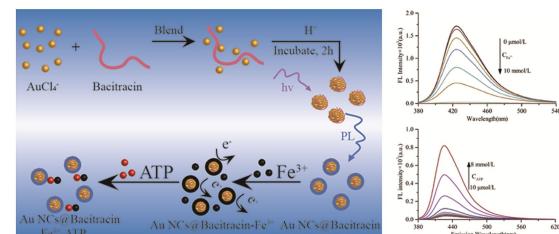
万方数据



# Fabrication of Bacitracin-Templated Gold Nanocluster and Its Application in Detection of Adenosine Triphosphate

RUAN Sheng-Li, ZHANG Ting-Ting,  
ZHANG Min\*, ZHANG Hong-Yang,  
WANG Yue-Rong, HU Ping\*

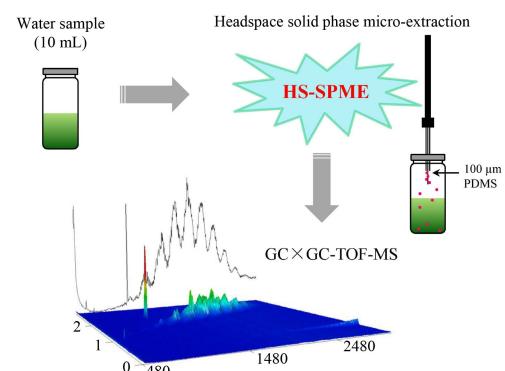
Chinese J. Anal. Chem., 2018, 46(12): 1997–2003



# Determination of Short-Chain Chlorinated Paraffins in Water by Headspace Solid Phase Micro-extraction and Comprehensive Two-dimensional Gas Chromatography Time-of-Flight Mass Spectrometry

ZHAN Nan, ZHU Shuai, GUO Feng, TIAN Qin,  
RAO Zhu\*

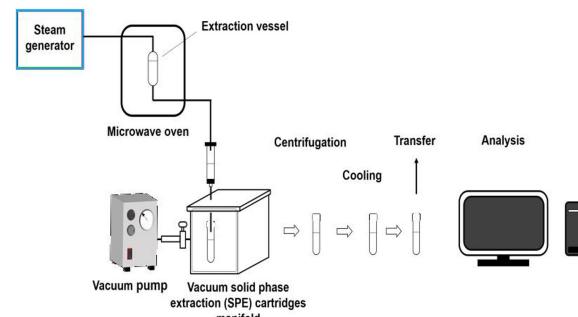
Chinese J. Anal. Chem., 2018, 46(12): 2004–2010



# Rapid Extraction of Triazine Herbicides in Cereal by Microwave-assisted Steam Extraction Combined with Solidification of Floating Organic Drop Method

LI Gui-Jie, WANG Da-Wei\*, DING Lan\*

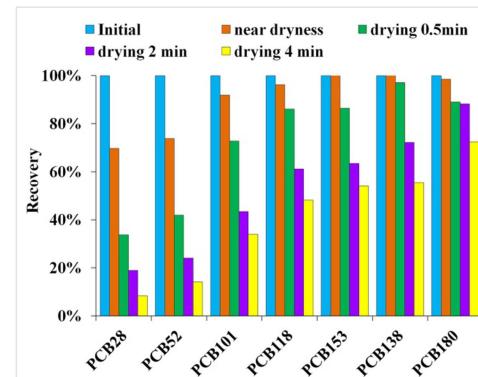
Chinese J. Anal. Chem., 2018, 46(12): 2011–2018



# Determination of Ultratrace Indicator Polychlorinated Biphenyls in Animal Feed by Gas Chromatography-Triple Quadrupole Mass Spectrometry with Isotope Internal Standards

WANG Rui-Guo, ZHANG Su, DONG Shu-Jun,  
WEI Shu-Lin, ZHANG Tian-Shu,  
YANG Hao-Sen, CHENG Jie, WANG Pei-Long,  
SU Xiao-Ou\*

Chinese J. Anal. Chem., 2018, 46(12): 2019–2024



\* The author to whom the correspondence should be addressed

The English electronic version of the article is published by Elsevier on ScienceDirect (<http://www.sciencedirect.com/journal/chinese-journal-of-analytical-chemistry>)