✓ **عنوان پژوهش:**

Surface-enhanced Raman scattering for medical diagnostics and biological imaging

✓ **نویسندگان:**

Vo-Dinh T., Yan F., Wabuyele M.B.

✓ **خلاصه پژوهش:**

We present recent development and applications of a surface-enhanced Raman scattering (SERS) technology for use in medical diagnostics and biological imaging. For medical diagnostics, we use Raman-active dye-labeled DNA gene probes and nanostructured metallic substrates as SERS-active platforms. The surface-enhanced Raman gene probes can be used to detect DNA biotargets (e.g. gene sequences, bacteria and viral DNA) via hybridization to DNA sequences complementary to these probes. The SERS gene probes eliminate the need for radioactive labels and have great potential to provide both sensitivity, selectivity and label multiplexing for DNA sequencing and clinical assays. We also describe a hyperspectral surface-enhanced Raman imaging (HSERI) system that combines imaging capabilities with SERS detection to identify cellular components with high spatial and temporal resolution. The HSERI system's application to biological imaging is demonstrated using Raman dye-labeled silver nanoparticles in cellular systems. Copyright © 2005 John Wiley & Sons, Ltd.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.1002/jrs.1348

✓ **نام ژورنال:**

Journal of Raman Spectroscopy

✓ **سال انتشار:**

2005

✓ **کلیدواژه‌ها:**

Cellular imaging; Gene detection; Nanostructured materials; Surface-enhanced Raman scattering

✓ **عنوان پژوهش:**

Medical applications of surface-enhanced Raman scattering

✓ **نویسندگان:**

Xie W., Schlücker S.

✓ **خلاصه پژوهش:**

This perspective article provides an overview of selected medical applications of surface-enhanced Raman scattering (SERS), highlighting recent developments and trends. The use of SERS for detection, analysis and imaging has attracted great interest in the past decade owing to its high sensitivity and molecular fingerprint specificity. SERS can deliver chemical and structural information from analytes rapidly and nondestructively in a label-free manner. Alternatively, SERS labels or nanotags, when conjugated to target-specific ligands, can be employed for the selective detection and localization of the corresponding target molecule. Biomedical applications based on both approaches are highlighted. © 2013 the Owner Societies.

✓ **لینک** DOI **(استفاده برای دانلود مقاله)**

10.1039/c3cp43858a

✓ **نام ژورنال:**

Physical Chemistry Chemical Physics

✓ **سال انتشار:**

2013

✓ **کلیدواژه‌ها:**

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✓ **عنوان پژوهش:**

Applications of surface-enhanced Raman scattering in advanced bio-medical technologies and diagnostics

✓ **نویسندگان:**

Nima Z.A., Biswas A., Bayer I.S., Hardcastle F.D., Perry D., Ghosh A., Dervishi E., Biris A.S.

✓ **خلاصه پژوهش:**

In this review of the literature on surface-enhanced Raman scattering (SERS), we describe recent developments of this technique in the medical field. SERS has developed rapidly in the last few years as a result of the fascinating advancements in instrumentation and the ability to interpret complex Raman data using high-processional, computer-aided programs. This technique, has many advantages over ordinary spectroscopic analytical techniques-such as extremely high sensitivity, molecular selectivity, intense signal and great precision-that can be leveraged to address complex medical diagnostics problems. This review focuses on the SERS-active substrate, as well as major advances in cancer and bacteria detection and imaging. Finally, we present a perspective on anticipated future advancements in SERS techniques to address some of the most critical challenges in the areas of diagnostics, detection, and sensing. © 2014 Informa Healthcare USA, Inc. All rights reserved: reproduction in whole or part not permitted.

✓ **لینک** DOI (**استفاده برای دانلود مقاله**)

10.3109/03602532.2013.873451

✓ **نام ژورنال:**

Drug Metabolism Reviews

✓ **سال انتشار:**

2014

✓ **کلیدواژه‌ها:**

Biomedical applications; Cancer cell detection; Surface-enhanced Raman spectroscopy

✓ **عنوان پژوهش:**

Nanostructured silver materials for noninvasive medical diagnostics by surface-enhanced Raman spectroscopy

✓ **نویسندگان:**

Semenova A.A., Semenov A.P., Gudilina E.A., Sinyukova G.T., Brazhe N.A., Maksimov G.V., Goodilin E.A.

✓ **خلاصه پژوهش:**

Noninvasive medical diagnostics as a modern research and application trend faces with a key problem of successive development of novel materials. Recently, new powerful approaches based on surface-enhanced Raman spectroscopy have become incredibly popular since they promise a unique analysis of biochemical processes on cell, cell organelle and molecular levels. Silver nanostructures and composites are preferred for such an analysis because of easier and more flexible preparation ways, better affinity to biological species, extraordinary spectral sensitivity and a wide variety of morphological forms of silver nanomaterials. © 2016 Mendeleev Communications. Published by ELSEVIER B.V.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.1016/j.mencom.2016.04.001

✓ **نام ژورنال:**

Mendeleev Communications

✓ **سال انتشار:**

2016

✓ **کلیدواژه‌ها:**

TEKSAN
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✓ **عنوان پژوهش:**

Detection and identification of medically important alkaloids using the surface-enhanced Raman scattering spectroscopy

✓ **نویسندگان:**

Volochanskyi O., Švecová M., Prokopec V.

✓ **خلاصه پژوهش:**

Currently, trace detection of drugs, medicinal products, psychoactive substances, poisons and other natural or synthetic compounds in the human body has become one of the most important areas of interest in medicine, toxicology and forensic research. Due to the rapid development of nanotechnology, applications in forensic and biological sciences, food industry and art preservation there is an increasing interest in surface-enhanced Raman scattering (SERS) spectroscopy as a technique capable of low detection limits in the analysis of small amounts of studied analytes. In this study, different excitation wavelengths (785 nm and 1064 nm) were used to find the appropriate experimental conditions for the detection and identification of medically significant alkaloids – atropine and pergolide – by means of surface-enhanced Raman scattering spectroscopy. SERS spectra of selected alkaloids were measured in the concentration range 10−3–10−9 mol·L−1 using large-scaled platinum substrates coated with electrochemically prepared gold or silver SERS-active layers. Identification was based on the assignment of surface-enhanced characteristic vibrational bands using theoretical (DFT) calculations and comparing them with normal (non-enhanced) Raman spectra of pure compounds. All sets of spectral data were subjected to multivariate statistical approach (partial least squares regression) aiming at prediction of alkaloids concentration in developed models and its comparison with experimental results. © 2018 Elsevier B.V.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.1016/j.saa.2018.09.009

✓ **نام ژورنال:**

Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy

✓ **سال انتشار:**

2019

✓ **کلیدواژه‌ها:**

Atropine; Gold substrates; Pergolide; Raman spectroscopy; SERS; Silver substrates

✓ **عنوان پژوهش:**

Raman and SERS microspectroscopy on living cells: A promising tool towards cellular-drug response and medical diagnosis

✓ **نویسندگان:**

Beljebbar Abdelilah, Sockalingum Ganesh D., Morjani Hamid, Manfait Michel

✓ **خلاصه پژوهش:**

Raman spectroscopy has been used to differentiate between sensitive and MDR-resistant cells using Raman spectral imaging with a 632.8 nm excitation wavelength. The comparison between two spectral images allowed to quantify the differences between sensitive and resistant cell lines in term of proteins, lipids when MDR phenotype is expressed. SER spectroscopy has become a powerful and non-invasive probe for investigating the molecular and cellular interaction of drugs with their targets (DNA, receptors, and enzymes). The comparison between these models allows to elucidate the biological effect of the drugs. The development of new types of SERS-active substrates has extended the applicability of this technique to medical diagnosis. Two kinds of SERS active substrates, characterized as `bio-compatible' systems, can be used for investigation on single living cells: colloid suspensions and microelectrodes (point probes) and island films (surface probes). This methodology is used for the study of cell membrane components in interaction with the SERS substrates with the aim to understand the resistance mechanism. The constitution of a data bank will allow the follow-up of cancer and future monitoring of therapeutic intervention.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

✓ **نام ژورنال:**

Proceedings of SPIE - The International Society for Optical Engineering

✓ **سال انتشار:**

1999

✓ **کلیدواژه‌ها:**

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✓ **عنوان پژوهش:**

SERS liquid biopsy: An emerging tool for medical diagnosis

✓ **نویسندگان:**

Moisoiu V., Iancu S.D., Stefancu A., Moisoiu T., Pardini B., Dragomir M.P., Crisan N., Avram L., Crisan D., Andras I., Fodor D., Leopold L.F., Socaciu C., Bálint Z., Tomuleasa C., Elec F., Leopold N.

✓ **خلاصه پژوهش:**

Surface-enhanced Raman scattering (SERS) is emerging as a novel strategy for biofluid analysis. In this review, we delineate four experimental SERS protocols that are frequently used for the profiling of biofluids: 1) liquid SERS for the detection of purine metabolites; 2) iodide-modified liquid SERS for the detection of proteins; 3) dried SERS for the detection of both purine metabolites and proteins; 4) resonant Raman for the detection of carotenoids. To explain the selectivity of each experimental SERS protocol, we introduce a heuristic model for the chemisorption of analytes mediated by adsorbed ions (adions) onto the SERS substrate. Next, we show that the promising results of SERS liquid biopsy stem from the fact that the concentration levels of purine metabolites, proteins and carotenoids are informative of the cellular turnover rate, inflammation, and oxidative stress, respectively. These processes are perturbed in virtually every disease, from cancer to autoimmune maladies. Finally, we review recent SERS liquid biopsy studies and discuss future steps that are required for translating SERS in the clinical setting. © 2021 Elsevier B.V.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.1016/j.colsurfb.2021.112064

✓ **نام ژورنال:**

Colloids and Surfaces B: Biointerfaces

✓ **سال انتشار:**

2021

✓ **کلیدواژه‌ها:**

Carotenoids; Proteins; Purine metabolites; SERS liquid biopsy; Surface-enhanced Raman scattering

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✓ **عنوان پژوهش:**

Applications of Surface-Enhanced Raman Scattering in Biochemical and Medical Analysis

✓ **نویسندگان:**

Szaniawska A., Kudelski A.

✓ **خلاصه پژوهش:**

In this mini-review, we briefly describe certain recently developed applications of the surface-enhanced Raman spectroscopy (SERS) for determining various biochemically (especially medically) important species from ones as simple as hydrogen cations to those as complex as specific DNA fragments. We present a SERS analysis of species whose characterization is important to our understanding of various mechanisms in the human body and to show its potential as an alternative for methods routinely used in diagnostics and clinics. Furthermore, we explain how such SERS-based sensors operate and point out future prospects in this field. © Copyright © 2021 Szaniawska and Kudelski.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.3389/fchem.2021.664134

✓ **نام ژورنال:**

Frontiers in Chemistry

✓ **سال انتشار:**

2021

✓ **کلیدواژه‌ها:**

cancer; cells; DNA; proteins; surface enhanced Raman spectroscopy; tissues

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✓ **عنوان پژوهش:**

Recent advances in SPR and SERS for sensitive translational medical diagnostics

✓ **نویسندگان:**

Wong C.L., Dinish U.S., Olivo M.

✓ **خلاصه پژوهش:**

Personalized medicine is revolutionizing modern health care. The aim of personalized diagnostics is to provide rapid, portable and simple tests that will reduce diagnosis time. They enable rapid analysis performed near the patient and provide specific details of the patient's condition so that a personalized treatment can be made. This review focuses on the recent advances in optical diagnostic techniques based on surface plasmon resonance (SPR) and surface-enhanced Raman scattering spectroscopy (SERS) for translational medical diagnostics. In the first part, recent developments in SPR biosensors for infectious disease diagnosis are presented including the first two-dimensional multiplex influenza SPR biosensor for H1N1 (influenza A) and H3N2 (seasonal influenza) detection. In the second part, advances in SERS, which is another ultra-sensitive optical diagnostic technique for various cancer detection applications in pre-clinical and clinical settings, are reviewed.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.1515/plm-2014-0009

✓ **نام ژورنال:**

Photonics and Lasers in Medicine

✓ **سال انتشار:**

2015

✓ **کلیدواژه‌ها:**

biosensor; cancer detection; infectious disease diagnosis; Review; surface plasmon resonance (SPR); surface-enhanced Raman scattering spectroscopy (SERS)

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✓ **عنوان پژوهش:**

Preparation and characterization of long-term stable SERS active materials as potential supports for medical diagnostic

✓ **نویسندگان:**

Nowak M., Trojanowska A., Marciniak L., Binczyk M., Runka T., Tylkowski B., Jastrzab R.

✓ **خلاصه پژوهش:**

Silver, gold and platinum architectures deposited on copper support have been proposed as long-lasting active materials successfully used in Surface-Enhanced Raman Spectroscopy (SERS). These novel hybrid materials are an attractive alternative to the unstable and short-term storable metal colloids. Environmental Scanning Electron Microscope (ESEM) equipped with Energy-Dispersive X-ray Spectroscopy (EDXS) and Contact Angle (CA) measurements were used to characterize obtained silver fern-like as well as gold and platinum nanocube/nanosphere structures, both: right after preparation and after 6 months of storage. Recorded Raman spectra of 10 μM Rhodamine 6G applied to the substrate corroborates strong enhancement of Raman signal and they are in accordance with theoretical calculations generated by Amsterdam Density Functional (ADF). SERS spectra are consistent with ESEM micrographs and confirmed the presence of a numerous hot spots occurring on the modified copper plates. © 2018 Elsevier B.V.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.1016/j.apsusc.2018.04.055

✓ **نام ژورنال:**

Applied Surface Science

✓ **سال انتشار:**

2019

✓ **کلیدواژه‌ها:**

Nanomaterials; Raman spectroscopy; Rhodamine 6G; SERS technique; Silver, Gold and Platinum nanostructures

✓ **عنوان پژوهش**:

Surface enhanced raman spectroscopy for medical diagnostics

✓ **نویسندگان**:

Jahn I.J., Radu A.I., Weber K., Cialla-May D., Popp J.

✓ **خلاصه پژوهش**:

[No abstract available]

✓ **لینک** DOI (**استفاده برای دانلود مقاله**)

10.1007/978-3-662-56333-5_1

✓ **نام ژورنال**:

Nanotechnology Characterization Tools for Biosensing and Medical Diagnosis

✓ **سال انتشار**:

2018

✓ **کلیدواژه‌ها**:

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✓ **عنوان پژوهش:**

Sers investigation on oligopeptides used as biomimetic coatings for medical devices

✓ **نویسندگان:**

Di Foggia M., Tugnoli V., Ottani S., Dettin M., Zamuner A., Sanchez-Cortes S., Cesini D., Torreggiani A.

✓ **خلاصه پژوهش:**

The surface-enhanced Raman scattering (SERS) spectra of three amphiphilic oligopeptides derived from EAK16 (AEAEAKAK)2 were examined to study systematic amino acid substitution effects on the corresponding interaction with Ag colloidal nanoparticles. Such self-assembling molecular systems, known as “molecular Lego”, are of particular interest for their uses in tissue engineering and as biomimetic coatings for medical devices because they can form insoluble macroscopic membranes under physiological conditions. Spectra were collected for both native and gamma-irradiated samples. Quantum mechanical data on two of the examined oligopeptides were also obtained to clarify the assignment of the prominent significative bands observed in the spectra. In general, the peptide–nanoparticles interaction occurs through the COO– groups, with the amide bond and the aliphatic chain close to the colloid surface. After gamma irradiation, mimicking a free oxidative radical attack, the SERS spectra of the biomaterials show that COO– groups still provide the main peptide–nanoparticle interactions. However, the spatial arrangement of the peptides is different, exhibiting a systematic decrease in the distance between aliphatic chains and colloid nanoparticles. © 2021 by the authors. Licensee MDPI, Basel, Switzerland.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.3390/biom11070959

✓ **نام ژورنال:**

Biomolecules

✓ **سال انتشار:**

2021

✓ **کلیدواژه‌ها:**

Amphiphilic oligopeptides; Biomimetic coating; DFT; Oligopeptide–surface interaction; Oxidative stress; SERS

✓ **عنوان پژوهش:**

Molecular SERS Nanoprobes For Medical Diagnostics

✓ **نویسندگان:**

Wang H.-N., Crawford B.M., Vo-Dinh T.

✓ **خلاصه پژوهش:**

For medical applications, practical and sensitive diagnostic techniques, capable of simultaneously detecting the presence of several biomarkers (i.e., multiplex detection) associated with a specific disease, are highly desirable. Nucleic acid biomarkers, such as DNA, mRNA, and microRNA, have long been considered valuable diagnostic indicators to monitor the presence and progression of various diseases. Much effort has been devoted to developing alternative detection strategies for nucleic acid biomarkers to overcome challenging analytical aspects in the laboratory. © 2018 by Taylor & Francis Group, LLC.

✓ **لینک** DOI (**استفاده برای دانلود مقاله**)

10.4324/9781315374581

✓ **نام ژورنال:**

Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, Second Edition

✓ **سال انتشار:**

2017

✓ **کلیدواژه‌ها:**

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✓ عنوان پژوهش:

SERS molecular sentinel nanoprobes to detect biomarkers for medical diagnostics

✓ نویسندگان:

Vo-Dinh T., Wang H.-N., Ngo H.T.

✓ خلاصه پژوهش:

Raman spectroscopy is a powerful analytical technique for chemical characterization due to the wealth of information on molecular structures, surface processes, and interface reactions that can be extracted from experimental data. e spectral selectivity associated with the narrow emission lines and the molecular specic vibrational bands of Raman labels make it an ideal tool for molecular genotyping. However, a limitation of Raman techniques for trace detection is the very weak Raman cross section. However, Raman spectroscopy has gained increasing interest as an analytical tool with the advent of the SERS eect, which can produce signicant enhancement of the Raman signal. It is believed that the origin of the enormous Raman enhancement is produced by at least two main mechanisms that contribute to the SERS eect: (1) an electromagnetic eect occurring near metal surface structures associated with large local elds caused by electromagnetic resonances, oen referred to as surface plasmons, and (2) a chemical eect involving a scattering process associated with chemical interactions between the molecule and the metal surface. Plasmons are quanta associated with longitudinal waves propagating in matter through the collective motion of large numbers of electrons. According to classical electromagnetic theory, molecules on or near metal nanostructures experience enhanced elds relative to that of the incident radiation. When a metallic nanostructured surface is irradiated by an incident electromagnetic eld (e.g., a laser beam), conduction electrons are displaced into frequency oscillations equal to those of the incident light. ese oscillating electrons, called surface plasmons, produce a secondary electric eld, which adds to the incident eld. ese elds can be quite large (106-to 107-fold, even up to 1015-fold enhancement at hot spots). When these oscillating electrons become spatially conned, as is the case for isolated metallic nanospheres or otherwise roughened metallic surfaces (nanostructures), there is a characteristic frequency (the plasmon frequency) at which there is a resonant response of the collective oscillations to the incident eld. is condition yields intense localized elds that can interact with molecules in contact with or near the metal surface [1-4]. In an eect analogous to a lightning rod eect, secondary elds can become concentrated at high curvature points on the roughened metal surface. © 2015 by Taylor & Francis Group, LLC.

✓ لینک DOI (استفاده برای دانلود مقاله)

10.1201/b17288

✓ نام ژورنال:

Biomedical Photonics Handbook, Second Edition: Therapeutics and Advanced Biophotonics

✓ سال انتشار:

2014

✓ کلیدواژه‌ها:

✓ **عنوان پژوهش:**

How Surface-Enhanced Raman Spectroscopy Could Contribute to Medical Diagnoses

✓ **نویسندگان:**

Szaniawska A., Mazur K., Kwarta D., Pyrak E., Kudelski A.

✓ **خلاصه پژوهش:**

In the last decade, there has been a rapid increase in the number of surface-enhanced Raman scattering (SERS) spectroscopy applications in medical research. In this article we review some recent, and in our opinion, most interesting and promising applications of SERS spectroscopy in medical diagnostics, including those that permit multiplexing within the range important for clinical samples. We focus on the SERS-based detection of markers of various diseases (or those whose presence significantly increases the chance of developing a given disease), and on drug monitoring. We present selected examples of the SERS detection of particular fragments of DNA or RNA, or of bacteria, viruses, and disease-related proteins. We also describe a very promising and elegant 'lab-on-chip' approach used to carry out practical SERS measurements via a pad whose action is similar to that of a pregnancy test. The fundamental theoretical background of SERS spectroscopy, which should allow a better understanding of the operation of the sensors described, is also briefly outlined. We hope that this review article will be useful for researchers planning to enter this fascinating field. © 2022 by the authors. Licensee MDPI, Basel, Switzerland.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.3390/chemosensors10050190

✓ **نام ژورنال:**

Chemosensors

✓ **سال انتشار:**

2022

✓ **کلیدواژه‌ها:**

Biosensor; Cells; DNA; Medical; Multiplexing; Nanosensor; SERS; Surface-enhanced Raman spectroscopy

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✓ **عنوان پژوهش:**

Promising methods for noninvasive medical diagnosis based on the use of nanoparticles: Surface-enhanced Raman spectroscopy in the study of cells, cell organelles and neurotransmitter metabolism markers

✓ **نویسندگان:**

Goodilin E.A., Semenova A.A., Eremina O.E., Brazhe N.A., Goodilina E.A., Danzanova T.Yu., Maksimov G.V., Veselova I.A.

✓ **خلاصه پژوهش:**

Application of advances in nanomedicine and materials science to medical diagnostics is a promising area of research. Surface-enhanced Raman spectroscopy (SERS) is an innovative analytical method that exploits noble metal nanoparticles to noninvasively study cells, cell organelles and protein molecules. Below, we summarize the literature on the methods for early clinical diagnosis of some neurodegenerative and neuroendocrine diseases. We discuss the specifics, advantages and limitations of different diagnostic techniques based on the use of low- and high molecular weight biomarkers. We talk about the prospects of optical methods for rapid diagnosis of neurotransmitter metabolism disorders. Special attention is paid to new approaches to devising optical systems that expand the analytical potential of SERS, the tool that demonstrates remarkable sensitivity, selectivity and reproducibility of the results in determining target analytes in complex biological matrices. © Pirogov Russian National Research Medical University. All rights reserved.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.24075/brsmu.2018.077

✓ **نام ژورنال:**

Bulletin of Russian State Medical University

✓ **سال انتشار:**

2018

✓ **کلیدواژه‌ها:**

Erythrocytes; Medical diagnostics; Mitochondria; Nanomaterials; Nanomedicine; Neurotransmitter markers; Noble metal nanoparticles; Surface-enhanced Raman spectroscopy

✓ **عنوان پژوهش:**

Plasmonic SERS nanochips and nanoprobes for medical diagnostics and bio-energy applications

✓ **نویسندگان:**

Ngo H.T., Wang H.-N., Crawford B.M., Fales A.M., Vo-Dinh T.

✓ **خلاصه پژوهش:**

The development of rapid, easy-to-use, cost-effective, high accuracy, and high sensitive DNA detection methods for molecular diagnostics has been receiving increasing interest. Over the last five years, our laboratory has developed several chip-based DNA detection techniques including the molecular sentinel-on-chip (MSC), the multiplex MSC, and the inverse molecular sentinel-on-chip (iMS-on-Chip). In these techniques, plasmonic surface-enhanced Raman scattering (SERS) Nanowave chips were functionalized with DNA probes for single-step DNA detection. Sensing mechanisms were based on hybridization of target sequences and DNA probes, resulting in a distance change between SERS reporters and the Nanowave chip's gold surface. This distance change resulted in change in SERS intensity, thus indicating the presence and capture of the target sequences. Our techniques were single-step DNA detection techniques. Target sequences were detected by simple delivery of sample solutions onto DNA probe-functionalized Nanowave chips and SERS signals were measured after 1h - 2h incubation. Target sequence labeling or washing to remove unreacted components was not required, making the techniques simple, easy-to-use, and cost effective. The usefulness of the techniques for medical diagnostics was illustrated by the detection of genetic biomarkers for respiratory viral infection and of dengue virus 4 DNA.
© 2017 SPIE.

✓ **لینک DOI (استفاده برای دانلود مقاله)**

10.1117/12.2267857

✓ **نام ژورنال:**

Progress in Biomedical Optics and Imaging - Proceedings of SPIE

✓ **سال انتشار:**

2017

✓ **کلیدواژه‌ها:**

DNA Biosensor; DNA Detection; Multiplex DNA Detection; SERS Chip; Surface-Enhanced Raman Scattering

✓ **عنوان پژوهش:**

SERS molecular sentinel nanoprobes to detect biomarkers for medical diagnostics

✓ **نویسندگان:**

Vo-Dinh T., Wang H.-N., Ngo H.T.

✓ **خلاصه پژوهش:**

[No abstract available]

✓ **لینک** DOI (**استفاده برای دانلود مقاله**)

✓ **نام ژورنال:**

Biomedical Photonics Handbook

✓ **سال انتشار:**

2014

✓ **کلیدواژه‌ها:**

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