

REVIEW

Miniature Mass Spectrometry for VOCs Analysis: Recent Developments in Instrumentation and Applications

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ABSTRACT

Rationale: Volatile organic compounds (VOCs) are critical indicators of environmental and biological processes and their analysis is essential for various applications, including environmental monitoring, food safety and clinical diagnostics.

Methods: Traditional mass spectrometry (MS) techniques, such as gas chromatography–mass spectrometry (GC–MS), are widely regarded as gold standards for VOCs detection. However, their lack of portability and limited real-time analytical capabilities hinder their widespread use in on-site and rapid detection applications. Miniature mass spectrometry has emerged as a promising solution by integrating compact instrumentation with innovative ionization techniques, including ultraviolet-based, plasma-based and electron ionization methods.

Results: Recent advancements in mini-MS have focused on enhancing portability, sensitivity and adaptability to complex sample matrices. These developments include the integration of novel sampling interfaces, such as membrane inlet and atmospheric pressure interfaces. Despite these advances, challenges remain in optimizing sensitivity, selectivity and compatibility with real-world samples.

Conclusions: This review synthesizes recent progress in the field of miniature mass spectrometry for VOCs analysis, emphasizing key technological innovations, such as ionization and sampling improvements, portable platform development. The review also explores mini-MS applications in food authenticity, clinical diagnostics, highlighting the growing potential of these technologies to revolutionize on-site, real-time VOCs detection across diverse fields.

1 | Introduction

Volatile organic compounds (VOCs) are key components of biomarkers [1] and environmental pollutants that impact air quality [2], human health [3] and industrial processes [4]. For trace VOC analysis, a variety of analytical techniques have been developed, including gas chromatography (GC), ion mobility spectrometry (IMS), electronic nose (E-nose) and Raman spectroscopy [4–8]. Among them, GC–MS remains one of the most recognized method due to its sensitivity and accuracy. Despite the excellent performance of lab-scale GC–MS, its limited portability, lack of real-time analysis capabilities and poor adaptability to complex matrices restrict its application in fields such as environmental

monitoring, food safety and clinical diagnostics, where rapid, on-site detection is essential.

In recent years, the development of mini-MS has overcome these challenges by integrating novel ionization techniques and compact instrumentation. Significant efforts have been dedicated to the miniaturization of MS for VOC analysis [9], focusing on sampling interfaces, ion sources, mass analyzers and integrated platforms to enhance portability, real-time detection and adaptability in diverse applications. The development of sampling interfaces for miniature mass spectrometers began with membrane inlet (MI) systems, which commercialized by various companies and are widely used for in situ

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The Top Books of the Year Recent Developments In Mass Spectrometry 6 The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous engrossing novels captivating the hearts of readers worldwide. Let's delve into the realm of popular books, exploring the captivating narratives that have charmed audiences this year.

The Must-Read : Colleen Hoover's "It Ends with Us" This heartfelt tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover expertly weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can prevail.

Uncover the Best : Taylor Jenkins Reid's "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reid's absorbing storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery.

Recent Developments In Mass Spectrometry 6 : Delia Owens' "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens crafts a tale of resilience, survival, and the transformative power of nature, entrancing readers with its evocative prose and mesmerizing setting.

These bestselling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of engaging stories waiting to be discovered.

The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts.

The Secret History is a masterful and gripping novel that will keep you speculating until the very end. The novel is a cautionary tale about the dangers of obsession and the power of evil.

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lampiran 1 lembar persetujuan menjadi responden - May 31 2022

web preoperative assessment of the patient by an anesthesiologist is necessary to provide optimal surgery conditions and have a good preoperative and post operative period

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skripsi hubungan dukungan keluarga dengan - Feb 08 2023

web salah satu cara mengetahui tingkat kecemasan pasien pre operasi adalah menggunakan instrumen amsterdam pre operative anxiety and information scale apais apais

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web kecemasan ringan 7 orang 18 4 mengalami kecemasan sedang dan 1 orang 2 6 mengalami kecemasan berat dengan kategori dukungan keluarga tinggi kesimpulan

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web hasil penelitian didapatkan bahwa gambaran tingkat kecemasan pada pasien pre operasi di ruang anggrek rsud sumedang lebih dari setengahnya dengan kecemasan sedang

pengaruh komunikasi terapeutik terhadap tingkat - Apr 29 2022

web jul 27 2021 hasil penelitian didapatkan bahwa lebih dari separoh 61 3 memiliki tingkat kecemasan berat lebih dari separoh 61 3 berjenis kelamin laki laki lebih dari separoh

hubungan pengetahuan pasien tentang informasi - Apr 10 2023

web respon psikologis yang biasanya terjadi pada pasien pre operasi adalah kecemasan kecemasan merupakan reaksi emosional terhadap penilaian individu yang subyektif

ameliyat Öncesi anestezi deĖerlendirme ministry - Aug 22 2021

[gambaran tingkat kecemasan pada pasien pre](#) - Oct 24 2021

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web tingkat kecemasan pasien pre operasi di ruangan bedah baji kamase 1 dan 2 di rsud labuang baji makassar penelitian dilakukan sejak 7 juni sampai dengan 7 juli 2013

pdf tingkat kecemasan pasien pre operasi di - Aug 14 2023

web mar 15 2019 hasil penelitian yaitu pasien pre operasi yang tidak mengalami kecemasan yaitu 16 54 responden 8 26 responden mengalami kecemasan ringan 5 16

hubungan pemenuhan informasi pre operasi dengan tingkat - Mar 29 2022

web operasi merupakan salah satu penyebab dari kecemasan pada pasien apendiksitis sehingga diperlukan manajemen tingkat kecemasan mengendalikan koping pasien

hubungan pengetahuan pasien tentang informasi pre operasi - Dec 06 2022

web pengaruh yang signifikan terhadap tingkat kecemasan pasien dengan tingkat korelasi menunjukkan arah negatif yang berarti semakin tinggi dukungan keluarga maka semakin