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BOOKS AND SOFTWARE IN REVIEW

Stefan Weigl (Ed.): Breath analysis: an approach for smart diagnostics

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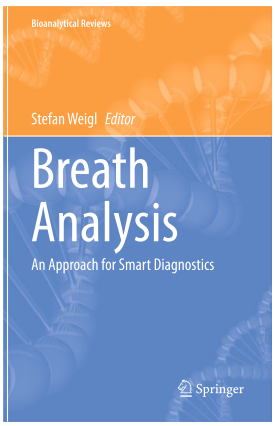

Bibliography
Breath analysis: an approach for smart diagnostics
Stefan Weigl (Ed.)
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Book's topic

Breath analysis is a multidisciplinary and innovative field of research, counting on the unique ability of the human lung to provide biofluids reflecting the health status of the person with every breath. Advancements in modern mass spectrometry (MS) instruments allow the encoding of thousands of unique substances in exhaled breath, notably different volatile organic compounds (VOCs), but also including DNA/RNA, virus particles, and pathogenic microorganisms when breath is condensed as breath aerosols or as exhaled breath condensate. The field of breathomics has advanced to a stage where it can offer solid evidence that breath can be considered as a new diagnostic matrix next to blood, urine, sweat, and saliva. In this context, the book "*Breath analysis: an approach for smart diagnostics*" by Stefan Weigl from the Springer Series Bioanalytical Reviews is an excellent contribution to breath analysis not only for analytical chemists but also for anybody interested in novel diagnostic approaches and point-of-care testing concepts, allowing hospital to home solutions with high patient compliance in the near future.

Contents

Insights into the advances of breath analysis, for future applications, are compiled as 7 chapters over a total of 240 pages. The first chapter focuses on the use of mass spectroscopy to monitor metabolic biomarkers in breath. The value of this chapter is that it describes the complexity of the task and underlines how pitfalls and challenges might be overcome to make breath of real potential to modern diagnostics. The two follow-up chapters underline improvements in analytical performance, when mass spectroscopy is coupled with gas chromatography and when gas chromatography is linked to ion mobility spectrometry, notably for the detection of VOCs in clinical settings. The fourth chapter introduces optical sensing approaches in the infrared region. Compared to online MS, optical spectroscopy can provide accurate and precise quantitative analysis results, with instruments that do not necessarily require an expert user. Photoacoustic spectroscopy is described in the fifth chapter and its application to breath analysis is revisited in depth. Finally, the sixth chapter discusses the technologically driven field of electric noses (e-noses). Electronic nose technology was introduced in 1982 for food identification and was gradually applied to other fields such as breath analysis. Common e-noses have several important components, notably gas sensor arrays and machine learning algorithms to allow identification of the analyte via recognition models. The book concludes with a chapter on pulmonary function diagnostics, notably the analysis of nitrogen oxide in human breath exhaled from patients with asthma, a common lung condition that causes occasional breathing difficulties.

Comparison with the existing literature

Breath analysis is undoubtedly a timely topic. Interest was largely revived and became, to some extent, one of the focal points during the COVID-19 pandemic. It was in spring of

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2022 when the U.S. Food and Drug Administration issued one of the first emergency use authorizations (EUAs) for the InspectIR COVID-19 Breathalyzer, a breath-based diagnostic tool that detects chemical compounds in breath samples associated with SARS-CoV-2 infection. The possibility to perform a test in doctor's offices, at mobile testing sites as well as in hospitals with results in some minutes, puts breath analysis back in the center of interest as a biofluid for respiratory diseases. The approach is not limited to identifying SARS-CoV-2 infection but is adaptable to influenza, tuberculosis, asthma, and other lung diseases including lung cancer.

A growing number of scientific articles, such as the perspective article by Giovannini, Haick, and Garoli in *ACS Sens.* 2021, 6, 4, 1408–1417 (*Detecting COVID-19 from breath: a game changer for a big challenge*), have been devoted to this topic and underline the advantages as well the challenges of breath analysis. Several books have been devoted to this topic, such as a systematic and comprehensive one on breath analysis and its medical applications by David Zhang, Dongmin Guo, and Ke Yan entitled "*Breath analysis for medical applications*" published in 2017 or the "*Breath analysis*" book by G. Pennazza and M. Santonico (Academic Press, 2018), offering guidance on how best to design the technology and conduct analyses with a primary focus on the diagnosis of lung cancer, asthma, and chronic obstructive pulmonary diseases.

Critical assessment

The present book focuses exclusively on the analysis of the gas phase of exhaled breath. One could see the field of breath analysis however becoming much larger. Breath is not comprised of only gases and VOCs, but also water droplets in form of suspended aerosols. The contents of these breath droplets are non-volatile metabolites, salts, lipids, protein biomarkers, as well as virus and pathogen particles, in fact, anything that is adsorbed and trapped on the surface of the respiratory tract. This might have been of added value to the book but would require the discussion of other analytical techniques in parallel, notably diagnostics, working in the liquid phase rather than gas sensors.

Readership recommendation

The book is aimed at researchers (senior/junior, PhD students) working in the field of breath analysis as well as researchers who are interested in, but new to, the field. The collection of chapters will give them a general overview of the analytical approaches used to screen breath and the first steps required for making breath analysis ready for smart diagnostics. The compilation of chapters is a great inspiration for analytical scientists and researchers, but might also be of interest to hospital technicians and leading hospital and biomedical SME figures who are not afraid of technical details.

Conclusion

Exhaled human breath analysis is a very promising field of research work with great potential for the diagnosis of diseases in non-invasive way. The years to come will show the potential of the concept "*Inhale the future, exhale the past*."

Declarations

Conflict of interest The author is editor of *Analytical and Bioanalytical Chemistry* but was not involved in the peer review of this article.