



HAL
open science

High sensing potentialities of tetra-tert-butyl-metallophthalocyaninesbased acoustic microsensors for xylenes measurement in air at room temperature

Jérôme Brunet, Alain Pauly, Christelle Varenne, Amadou Ndiaye, Thiaka Gueye, Abhishek Kumar

► To cite this version:

Jérôme Brunet, Alain Pauly, Christelle Varenne, Amadou Ndiaye, Thiaka Gueye, et al.. High sensing potentialities of tetra-tert-butyl-metallophthalocyaninesbased acoustic microsensors for xylenes measurement in air at room temperature. *Sensors* 2022, Oct 2022, Athènes, Greece. hal-03852593

HAL Id: hal-03852593

<https://hal.science/hal-03852593v1>

Submitted on 15 Nov 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

High sensing potentialities of tetra-tert-butyl-metallophthalocyanines-based acoustic microsensors for xylenes measurement in air at room temperature.

J. Brunet ^{1,*}, A. Pauly ¹, C. Varenne ¹, A.L. Ndiaye ², T. Gueye ¹, A. Kumar ³

¹ Université Clermont Auvergne, Clermont Auvergne INP, CNRS, Institut Pascal, F-63000 Clermont-Ferrand, France.

² CNRS, Institut Pascal, Université Clermont Auvergne, F-63000 Clermont-Ferrand, France

³ Institut de Chimie Moléculaire de l'Université de Bourgogne, UMR CNRS 6302, Université Bourgogne Franche-Comté, 9 Avenue Alain Savary, Dijon Cedex 21078, France

Abstract:

Xylenes, classified as Volatil Organic Compounds, is a very harmful pollutant for human health that can be absorbed into the body via all exposures routes: inhalation, ingestion, or dermal. As defined by the US Environmental Protection Agency, the occupational exposure limits are set to 100 ppm while the guidelines in non-occupational context are fixed to 50 ppm. For the concentration measurements in the atmosphere, authorities commonly used sampling methods with post-exposure chemical titration or chromatography. A strong interest remains on the development of low cost, low power consumption and easy implemented microsensors able to deliver real-time indicative measurements in the ppm concentration range.

Most of microsensors aimed to the quantification of xylene concentration in air implement doped MOx [1,2], MOx nanocomposites [3,4] or Metallic Oxide Frameworks [5]. Despite their suitability for xylene detection into the ppm concentration range, the main drawback remains the high required operating temperature (>250 °C). During this lecture, the high potentialities of acoustic microsensors with tetra-tert-butyl metallophthalocyanine as sensing materials for xylene monitoring will be highlighted. If neither the nature of the metallic layer used as an electrode on quartz, nor the nature of the central metal atom in the phthalocyanine macrocycle have no impact on the sensor responses, the sensing enhancement provided by butyl groups is established. Experimental results revealed that ttb-CuPc based QCM sensors are suitable for accurate measurements of xylene concentration from 50 to 500 ppm, without any hysteresis effect, at room temperature. The response and recovery times were assessed close to 3min, while the LOD to a few ppm, and a good repeatability is manifest. The cross-sensitivities were determined towards various VOCs and NO₂, with higher responses obtained for xylenes (Fig.1). The influence of relative humidity of gas mixture on response was investigated and will be discussed.

Keywords: Substituted phthalocyanines, Organic semi-conductor, Quartz Crystal Microbalance, acoustic sensors, Xylenes, Volatiles Organic Compounds, gas microsensors, pollutant monitoring.

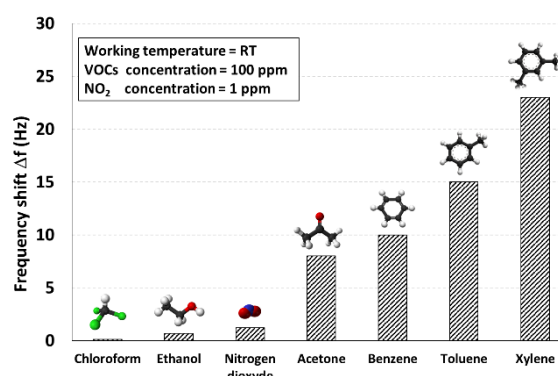


Figure 1: Intercomparison of ttb-CuPc-based QCM responses towards NO₂ and Volatils Organic Compounds at room temperature. The stabilized responses were obtained after 3 minutes of pollutant exposure and a temperature drift compensation was applied to each measured frequency.

References:

1. T.H. Kim et al (2019) Dual-mode gas sensor for ultrasensitive and highly selective detection of xylene and toluene using Nb-doped NiO hollow spheres, *Sens. Actuators B Chem.*, 301, 127140.
2. H. Gao et al (2019) Ultrasensitive gas sensor based on hollow tungsten trioxide-nickel oxide nanoflowers for fast and selective xylene detection, *J. Colloid Interface Sci.*, 535, 458-468
3. B.Y. Kim et al (2016) Highly Selective Xylene Sensor Based on NiO/NiMoO₄ Nanocomposite Hierarchical Spheres for Indoor Air Monitoring, *ACS Appl. Mater. Interfaces*, 8, 34603–34611.
4. H. Wang et al (2020) Ultrasensitive xylene gas sensor based on flower-like SnO₂/Co₃O₄ nanorods composites prepared by facile two-step synthesis method, *Nanotechnology*, 31, 255501.
5. T. Xu et al (2016) Metal–Organic Frameworks for Resonant-Gravimetric Detection of Trace-Level Xylene, *Molecules Anal. Chem.*, 88, 12234–12240.