

Objectif : Air intérieur, ventilation, climatisation et propagation du Covid-19

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Google Scholar, Lens et WoS

Yang, Q.-Y., Zhang, X., Chen, S., Yu, Y.-L.

[3D-printed and in situ grown lanthanide MOF sensor array toward colorimetric profiling of volatile organic compounds.](#)

Sensors and Actuators B: Chemical, Vol. **468**, (2026)

Metal-organic frameworks (MOFs) are attractive optical sensing materials, yet their intrinsic fragility and poor processability have hindered the fabrication of macro-scale optical device. Herein, a colorimetric sensor array (CSA) is designed by in situ growing and assembling lanthanide MOF (Isg-LnMOF) on a 3D-printed frame for the identification and detection of eight volatile organic compounds (VOCs). The 3D-printed frame was fabricated by a precursor ink containing organic ligands, alginate, deprotonation agent and commercial resins, and then immersed in a lanthanide ion solution to trigger in situ growth and assembly of LnMOF (LnTb, Eu, Sm) through ion coordination and chelation. Compared to LnMOFs synthesized via various assembly methods, Isg-LnMOF exhibits a dense and uniform morphology, enhanced stability, and superior reproducibility (RSD=1.0–1.5%). Principal component analysis (PCA) and linear discriminant analysis (LDA) are employed for classification of eight VOCs and quantitative analysis of individual VOCs, respectively. The Isg-LnMOF CSA can unambiguously identify the eight VOCs, and achieves the detection limits of 2.6–5.1 ppm. The CSA also successfully discriminates binary VOCs mixtures and a simulated ternary industrial exhaust (acetone/benzene/toluene), with distinct clustering in PCA space. This demonstrates its potential as a colorimetric sensing platform for VOCs monitoring applications, including industrial emission control, indoor air quality assessment, and occupational exposure monitoring.

Ahmadzadeh, M., Quemerais, B., Debia, M., Hashisho, Z.

[CFD-based Assessment of Welders' Exposure to Welding Fumes in a Real-World Booth.](#)

Process Safety and Environmental Protection, (2026)

Welding produces hazardous gases, fumes, and vapors, posing health risks to operators. Practical mitigation strategies are limited. This study applied CFD to simulate welding fumes in a full-scale booth. The model specifically aims to analyze welding fume concentrations and deposition in the breathing zone across various design settings, providing practical strategies to enhance welder protection. Key exposure indicators, including airborne suspension, particle escape fraction, and deposition within the welder's breathing zone, were quantified under different scenarios, such as ventilation rates, local exhaust ventilation (LEV) placement, ceiling geometry, and welding duration. Results indicate that doubling the inlet air velocity reduced exposure levels by 36%. Moreover, the findings demonstrate that LEV systems play a critical role in improving protection within welding workshops. Positioning the LEV directly above the welding zone, at a short distance from the welding table, reduced exposure to below 1% of the total injected particles. Additionally, pyramidal ceiling configurations were more effective in facilitating the extraction of vertical fumes compared to flat ceilings. Longer welding durations substantially increased cumulative emissions and exposure levels. These findings highlight the importance of an integrated approach that combines optimized airflow dynamics, effective LEV placement, and suitable design configurations that effectively enhance welders' protection.

Rachmawardani, A., Galuh, A. D., Arinio, E. D. W.

Characterization of MQ-2, MQ-7 and MQ-135 Gas Sensors for Arduino-Based Smoke Detection.

Prisma Sains : Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram, Vol. **14** n°(3), (2026), 1718–1732 p.

<p>Smoke detection in enclosed spaces is important for early fire detection and air-quality monitoring. This paper characterizes and compares the performance of three MQ-series gas sensors (MQ-2, MQ-7 and MQ-135) under an Arduino UNO R3-based system. Three smoke sources (paper combustion, cigarette smoke, and motorcycle exhaust) were evaluated against a commercial CO detector. Parameters assessed include linearity, sensitivity, response time, error, measurement uncertainty (ISO GUM), and output-voltage correction. MQ-2 and MQ-7 exhibit logarithmic voltage–concentration relationships consistent with the power-law model of SnO₂-based metal-oxide-semiconductor sensors, while MQ-135 exhibits a quadratic pattern; all R² values exceed 0.98. MQ-7 produced the lowest errors among the three sensors for paper combustion and cigarette smoke, indicating suitability for indicative early-warning detection; however, its best-case relative error of 38% confirms it is unsuitable for precise quantitative CO monitoring without additional calibration. The three sensors exhibited errors exceeding 85% for motorcycle exhaust due to cross-sensitivity resulting from the complex chemical composition of engine exhaust. A voltage-correction analysis showed the errors in Arduino ADC readings were less than 6%, confirming the reliability of the electronic system; this does not mean the accuracy of the gas concentration will be the same, since it depends on the selectivity of the sensors, calibration and environmental conditions.<p>

Liu, T., Du, B., Khovalyg, D., Licina, D.

A controlled chamber study of sensor placement and personalized modeling for breathing-zone CO₂ and particle detection in offices.

Building and Environment, Vol. **305**, (2026)

Accurately and practically estimating breathing-zone pollutant concentrations remains a key challenge for personal inhalation exposure assessment in office environments. We conducted controlled human-subject experiments in a climate chamber configured to simulate a mechanically ventilated shared office with HEPA-filtered supply air and no outdoor air infiltration under multiple indoor air quality and thermal conditions. Minute-resolved measurements of CO₂, PM_{2.5}, and PM₁₀ were collected simultaneously at the breathing zone and at several practical sensor locations around the workstation and room. Using these data, we systematically evaluated sensor relevance and redundancy through correlation analysis and complementary linear and nonlinear modeling. The results showed clear pollutant-specific differences in sensor placement performance within the tested chamber configuration: breathing-zone CO₂ could be reasonably estimated using a single desk-level sensor placed above the laptop, whereas PM_{2.5} and PM₁₀ required a combination of room-center and desk-left-side measurements, reflecting stronger spatial heterogeneity under the tested low-source, filtered-air conditions. Models trained on the selected sensor sets generalized well across participants and controlled environmental conditions. Compared with conventional room-level sensing, using the selected sensor configurations improved overall breathing-zone estimation by approximately 14% for CO₂, 17% for PM_{2.5}, and 3% for PM₁₀. Personalized residual modeling then provided additional individual-level improvements by approximately 38%, 5%, and 11%, respectively. These findings provide controlled experimental evidence for pollutant-specific sensor placement and personalized modeling strategies to support practical breathing-zone exposure estimation in office environments.

Matamoras Pacheco, M., Sánchez Montaña, M. E., Gragera Fernández, Ó., Hernández Gutiérrez, J. D., Reyes Rodríguez, A. M.

Desarrollo y validación preliminar de un dispositivo low cost para garantizar la calidad del aire interior optimizando el consumo energético (Proyecto qIA).

(2026)

El proyecto qIA aborda el desarrollo de un dispositivo de bajo coste para anticipar episodios de radón en espacios interiores y proporcionar señales de control que permitan ventilar de forma preventiva, evitando el funcionamiento continuo de los sistemas de ventilación. La solución integra un nodo IoT basado en Arduino UNO R4 WiFi, sensores de temperatura, humedad relativa, CO, CO₂, material particulado y radiación gamma, una cadena de adquisición y preprocesamiento implementada con Node-RED, almacenamiento local y un modelo de aprendizaje automático desplegable mediante una API REST. La campaña experimental empleó tres nodos Arduino, un monitor Airthings Wave Plus como referencia de radón y una estación meteorológica exterior, con muestreo cada 10 min. Tras depurar lecturas físicamente imposibles, limitar la interpolación a huecos de las variables predictoras y generar retardos y medias móviles, se compararon seis algoritmos de regresión. El modelo final, LightGBM entrenado con 3.236 registros válidos del nodo A2 y ocho variables, alcanzó $R^2 = 0,592$ en prueba para un horizonte de una hora, MAE = 31,9 Bq/m³ y sesgo medio = -1,6 Bq/m³; el 79,5 % de las predicciones presentó un error absoluto inferior a 50 Bq/m³. El sistema se productivizó en un microservicio con histórico local, caché meteorológica y comunicaciones cifradas. Los resultados demuestran la viabilidad de una alerta predictiva con el empleo de un dispositivo de bajo coste.

Lamgunde, K. S., Kumbhar, S. S., Jagtap, O. A., Sabale, A. N.

[Design and Development of an All-Direction Air Cooler for Uniform Air Distribution.](#)

International Journal of Scientific Research in Engineering and Management, Vol. **10** n°(7), (2026)

Air coolers are widely used as an economical and energy-efficient alternative to conventional air conditioning systems. However, most existing tower air coolers deliver airflow in a single direction and rely on oscillating mechanisms to distribute cool air, resulting in uneven air circulation, increased mechanical complexity, and reduced cooling effectiveness in larger spaces. This paper presents the design and development of an All Direction Tower Air Cooler, featuring a unique cylindrical configuration with circumferential air outlets that enable uniform air distribution in all directions without requiring an oscillation mechanism. The proposed design integrates evaporative cooling technology with a centrally positioned centrifugal blower, honeycomb cooling pads, and strategically designed radial airflow channels to enhance indoor thermal comfort while maintaining low energy consumption. A three-dimensional CAD model is developed to illustrate the structural configuration, and the conceptual airflow pattern is analyzed to evaluate the effectiveness of the multi-directional air distribution system. The proposed design offers improved room-wide cooling, compact construction, aesthetic appeal, simplified maintenance, and environmentally friendly operation. Owing to its innovative external configuration and efficient airflow distribution, the All Direction Tower Air Cooler has significant potential for residential, commercial, educational, and institutional applications. The study provides a foundation for future computational fluid dynamics (CFD) analysis, prototype development, and experimental performance evaluation to validate the proposed concept.

Aliu, D., A. B, I.

[Design, Implementation, and Performance Evaluation of a Real-time Industrial Air Quality Monitoring System using ESP32 and Multi-gas Sensors.](#)

ATBU Journal of Science, Technology and Education; Vol 14, No 2 (2026), (2026)

Industrial air pollution poses significant risks to human health and environmental sustainability, particularly in regions affected by mining and other industrial activities. Pollutants such as ozone (O₃), carbon monoxide (CO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and particulate matter, as observed in Ikpeshe and Iloke due to mining operations in Edo State, Nigeria, contribute to both acute and chronic health conditions, including cardiovascular diseases, lung cancer, and respiratory infections. Conventional air-quality monitoring systems are often expensive, difficult to deploy, and limited in their ability to provide

continuous, remotely accessible data. This study presents the design, implementation, and performance evaluation of a cost-effective, real-time industrial air-quality monitoring system based on the Internet of Things (IoT). The system utilizes an ESP32 Wi-Fi microcontroller integrated with MQ-135 and MQ-2 gas sensors to detect variations in air pollutants and combustible gases. An OLED display and the Blynk IoT platform facilitate both local and remote access to monitoring data. The system was designed and simulated in Proteus and implemented in a compact 3D-printed enclosure. Experimental evaluation examined sensor responses to different gas-source proximities, carbon monoxide generated during wood combustion, and changes in the air quality index (AQI). Results demonstrated a direct correlation between pollutant-source proximity and sensor response: sensor resistance decreased, and output voltage increased as the gas source approached the sensing elements. In the carbon monoxide experiment, measured concentrations increased from 10 ppm as smoke accumulated in an enclosed environment, confirming the system's ability to detect declining air quality. Similarly, the AQI rose from 24 under baseline conditions to hazardous levels after petroleum exposure, then decreased after the pollutant source was removed. The complete system consumed approximately 3.33 W, with an estimated battery operating time of 5.3 hours. These findings suggest that the proposed IoT-enabled system provides a compact, low-power, and remotely accessible solution for real-time air-quality monitoring and early pollution alerts in industrial environments. The system offers potential for affordable environmental monitoring and could be further enhanced through sensor calibration, expanded pollutant detection, and integration with advanced data analytics.

Jelašić, M., Irrenfried, C., Kozmar, H.

[The Effect of Wind Incidence Angle on Wind-Driven Natural Ventilation of Airport Terminals.](#)

International Conference of the Italian Association for Wind Engineering. 13.0-16.09.2026. Bari, Italy

The wind-driven natural ventilation of airport terminals is a promising solution for reducing energy demand and improving indoor air quality. This study focuses on the effects of wind incidence angles on the wind-driven natural ventilation of a generic airport terminal building equipped with four roof-mounted windows. Small-scale model experiments were performed in a boundary layer wind tunnel. Ventilation performance was quantified using the tracer gas method to determine the air change rate ACH. Vertical flow velocity component near the roof openings was measured using hot-wire sensors. Measurements were performed at the mean freestream flow velocity $u = 7$ m/s for the flow incidence angles in the $0^\circ < \beta < 360^\circ$ range. The results show that the optimal ventilation occurs at $\beta = 180^\circ$ and 330° , while the minimum ventilation performance is achieved at $\beta = 90^\circ$.

Sosa Zambrano, K. X., Cedeño Mendoza, R. E.

[Estudio del Efecto de la Recirculación de Aire y la Concentración de CO₂ en el Habitacióno Vehicular.](#)

Reincisol., Vol. 6 n°(10), (2026)

El estudio analizó el efecto de la recirculación de aire sobre la concentración de dióxido de carbono (CO₂) en habitáculos vehiculares, considera su relación con la calidad del aire interior, el confort térmico y la eficiencia energética del sistema de climatización. Se desarrolló una revisión bibliográfica estructurada, de enfoque documental, descriptivo y analítico, mediante búsquedas realizadas entre mayo y julio de 2026 en Scopus, Google Scholar, SciELO y ScienceDirect. De 134 registros inicialmente identificados, 20 estudios cumplieron los criterios de inclusión establecidos y conformaron la muestra final. Los resultados evidenciaron que la concentración de CO₂ aumenta cuando disminuye la renovación del aire, especialmente en condiciones de recirculación sostenida, mayor número de ocupantes y tiempos prolongados de permanencia. También se determinó que la recirculación puede reducir el ingreso de partículas provenientes del exterior y disminuir la demanda energética del sistema HVAC, aunque estos beneficios pueden acompañarse de una mayor acumulación de CO₂. La comparación de estrategias

técnicas mostró que no existe un porcentaje único de recirculación aplicable a todas las condiciones de conducción. Los sistemas de ventilación variable y control dinámico, apoyados en sensores de CO₂ y en variables como ocupación, demanda térmica y calidad del aire exterior, presentan mejores posibilidades para equilibrar ventilación, confort y eficiencia energética. Se concluye que el uso de la recirculación debe gestionarse de manera adaptativa y no como una condición permanente de funcionamiento.

Huang, M., Tsuchi, K., Shiraishi, Y., Noguchi, S., Inoue, D., Tanaka, H.

[Evaluation of the thermal and airflow performance of a Coanda-effect-based radiant air conditioning system in office spaces.](#)

Frontiers of Architectural Research, (2026)

Achieving both energy conservation and improved indoor environmental quality in buildings is a critical challenge in architectural engineering. This study proposes a line-type Coanda air-conditioning system integrating Coanda-effect airflow control with ceiling radiant cooling. The system performance was evaluated by CFD analysis using a 3D full-scale office model. Case studies focused on the Archimedes number (Ar), including conditions with a fixed setpoint temperature and varying Ar, and fixed Ar with varying supply air temperature. Results show that decreasing Ar increases the Coanda airflow separation distance, reduces draft risk, and improves the Air Diffusion Performance Index (ADPI) from 84.59% to 88.74%. When Ar is constant, changes in supply air temperature do not significantly alter airflow characteristics, and suitable thermal conditions can be maintained according to the room setpoint temperature. Compared with a conventional convective system and an air-supplied ceiling radiant system, the proposed system achieved ADPI values of 87.8% (ceiling exhaust) and 87.0% (floor exhaust), with mean PMV values near neutrality (0.01 and -0.06). These findings demonstrate its effectiveness in providing a favorable thermal environment and design flexibility in office spaces.

Liu, R., Fang, W., Zhu, L., Chu, X., Liang, S.

[FSCOFs/In₂O₃ composites as high-performance gas sensors for formaldehyde detection.](#)

Journal of Alloys and Compounds, Vol. **1080**, (2026)

The development of chemiresistive sensors capable of conveniently and efficiently detecting formaldehyde (HCHO) in complex environments remains a significant challenge. In this work, the composite material featuring hydroxylated imine-linked covalent organic frameworks (FSCOFs) integrated with In₂O₃ was successfully fabricated via a facile ultrasonic dispersion method. Unlike conventional carbon-based modifiers, FSCOFs possess a unique combination of periodic micropores and dense surface hydroxyl groups, which synergistically endow the composite with exceptional selectivity. The characterization reveals that the integration of FSCOFs with In₂O₃ not only significantly enhances the specific surface area but also promotes a substantial increase in the oxygen vacancy concentration, thereby effectively increasing the density of surface active sites. Gas-sensing tests demonstrate that the optimized FSI-3 (3 wt% FSCOFs) exhibits superior performance, achieving a high response of 32.4 to 100 ppm HCHO at 170°C, which is approximately 9.26 times higher than that of pure In₂O₃. This enhanced selectivity stems from a distinctive dual-mechanism: specific hydrogen bonding between the abundant -OH groups on FSCOFs and the polar CO bond of HCHO, coupled with steric hindrance imposed by the microporous architecture against bulkier interfering molecules. Furthermore, the sensor boasts a low detection limit of 0.1 ppm and excellent short-term repeatability. Practical evaluations involving the detection of low-concentration HCHO emitted from paint further confirm the reliability and potential of this material for real-world indoor air quality monitoring.

Song, X., Zhang, X., Su, X., Liang, X., Lv, Y., Xu, J., *et al.*

[Hierarchical flower-like WO₃-based sensor with high sensitivity and low detection limit for indoor xylene rapid detection.](#)

Microchemical Journal, Vol. **230**, (2026)

As a common indoor aromatic volatile organic pollutant, accurate and sensitive monitoring of xylene is essential for residential health protection. In this work, monoclinic WO₃ materials with tunable microstructures were synthesized via a solvothermal synthesis by adjusting the water/ethanol solvent ratio. The regulation effect of solvent composition on crystal facet exposure, defect content and morphology of the materials was systematically analyzed. The gas sensing measurements reveal that the hierarchical flower-like WO₃ microsphere sensor (synthesized at water/ethanol = 2:1) exhibits a response of 25.9 toward 100 ppm xylene at 220 °C, which is 3-fold higher than that of the sensor fabricated with pure water as the solvent. It also features 1 s ultrafast response, excellent selectivity, 30-day long-term stability, and a 52 ppb detection limit. The superior performance originates from the combined contributions of the nanosheet size effect, efficient gas diffusion pathways of the hierarchical architecture, and abundant surface active sites. The portable early warning system developed with this material enables real-time indoor xylene monitoring, providing a new strategy for high-performance gas sensing material design.

Uçak, E., Pekerikli, M. K., Topak, F.

Indoor Air Quality Implications of Additive Manufacturing in Hybrid Workplaces.

Buildings, Vol. **16** n°(17), 2026, pp. 3411

Additive manufacturing (AM) technologies are increasingly being integrated into work environments, making the coexistence of production and office activities within hybrid workplaces more common and raising concerns regarding indoor air quality (IAQ) in shared or adjacent workplace environments. Although emissions associated with AM processes have been examined, limited attention has been given to IAQ conditions in hybrid workplaces where production and office functions share the same indoor environment. This study investigates the IAQ conditions associated with selected powder bed fusion and vat photopolymerization operations in a hybrid workplace through real-time environmental monitoring and employee perception analysis. Field experiments were conducted during pre-printing, printing, post-printing, and post-processing phases. Two custom-designed instruments, the Indoor Network-Based Air-Sensing Ecosystem (INBASE) and the Indoor Air Quality Polling Instrument (AIRPOLL), were developed to monitor particulate matter, volatile organic compounds, formaldehyde, benzene, ethanol, nitrogen dioxide, carbon dioxide, and oxygen and collect employee feedback. Findings showed that pollutant concentrations varied by process type, operational phase, and monitored space. Higher concentrations, particularly of volatile organic compounds, were observed in production spaces, while most other parameters remained within reference values. Employee feedback indicated positive perceptions in office spaces and greater concerns in production spaces. The findings support the importance of ventilation, spatial separation, and continuous monitoring in AM-integrated hybrid workplaces.

Hu, Z., Gu, S., Feng, B., Mao, D., Li, K., Zhou, L., *et al.*

Multi-objective ventilation optimization in non-unidirectional cleanrooms: an integrated RSM-NSGA-II-TOPSIS approach.

Building and Environment, Vol. **305**, (2026)

Modern cleanrooms are characterized by high energy intensity and stringent cleanliness requirements, demanding the simultaneous optimization of energy efficiency, contaminant removal, and occupant comfort. This study proposes a multi-objective optimization framework integrating response surface methodology (RSM), NSGA-II, and EWM-TOPSIS. Explicit surrogate models were developed for three design parameters, namely FFU-perforated floor coverage, air changes per hour (ACH), and raised floor height, to quantify their individual and interactive effects on workspace satisfaction (WS), thermal utilization effectiveness (TUE), and clean ventilation index (CVI). NSGA-II achieved a well-converged Pareto front, from which EWM-TOPSIS identified the globally optimal design: an ACH of 69.50 h⁻¹, a raised floor height of 625 mm, and a coverage level of 75%. This configuration yielded a WS of 88.46, a TUE of 0.63, and a

CVI of 3.06. The TOPSIS-optimal solution was further validated against CFD simulations, with relative errors below 3.1% for all three objectives. The framework offers a robust approach to balanced, high-efficiency cleanroom design, though its generalizability warrants further validation across different cleanroom classes, equipment layouts, and operating conditions.

Utami, S. N., Srisantyorini, T.

Occupational Safety and Health Risk Assessment Among Office Employees at the Environmental Agency of Karawang Regency.

Journal of Community Health Provision, Vol. 6 n°(3), (2026), 886–898 p.

Office work environments are exposed to various occupational hazards that may affect occupational safety and health (OSH). This study aimed to identify workplace hazards, assess occupational risks using the Hazard Identification, Risk Assessment, and Determining Control (HIRADC) method, and analyze factors associated with OSH risk among office employees at the Environmental Agency of Karawang Regency, Indonesia. A quantitative cross-sectional study was conducted involving 63 employees selected through total sampling. Data were collected using HIRADC observations and structured questionnaires and analyzed using univariate analysis, Chi-square test, and binary logistic regression. The results identified 20 workplace hazards, consisting of 1 low-risk (5.0%), 14 medium-risk (70.0%), and 5 high-risk (25.0%) hazards. Bivariate analysis revealed that physical factors ($p < 0.001$) and safety factors ($p = 0.001$) were significantly associated with OSH risk levels. Multivariate analysis indicated that safety factors were the strongest predictor of OSH risk ($OR = 6.594$; $p = 0.011$), followed by physical factors ($OR = 4.786$; $p = 0.029$). Periodic implementation of HIRADC and strengthening of the Occupational Safety and Health Management System (OSHMS) based on ISO 45001:2018 are recommended to reduce occupational risks and improve workplace safety in office environments.

Zhang, Z., Zhao, X., Tang, B., Xiao, Y., Tan, Z., Sun, X., *et al.*

Operational performance of a fresh air preheating system integrated with natural cold storage using natural cold air.

Energy, Vol. 363, (2026)

To reduce the energy demand of fresh-air handling in conventional air-conditioning (AC) systems and improve the utilization of natural cold resources, this study proposes a fresh-air handling system integrated with natural cold storage. It uses winter ambient cold air to drive a coil-type cold storage unit for natural cold energy storage, and innovatively integrates an air heat exchanger for fresh-air preheating. The stored cold energy is subsequently used for summer fresh air precooling, enabling seasonal cold-energy utilization and reducing fresh-air handling energy consumption. An experimental platform was built in an enthalpy-difference laboratory (EDL) to study the effects of ambient temperature (AT), air velocity (AV), and glycol solution flow rate (GSFR) on fresh-air preheating, cold storage behavior, and system efficiency. A TRNSYS engineering model was established to assess the effects of climate and operation strategy on annual performance. The experimental results indicate that system performance is primarily affected by AT, followed by AV, whereas GSFR has a relatively minor influence. At ATs of -5 to -20 °C, the initial fresh air temperature rise (FATR) is 8.7 °C– 15.7 °C and later remains at 3.5 °C– 8.7 °C. For every 5 °C decrease in AT, the initial and final FATR increased by approximately 2.1 °C– 2.5 °C and 0.84 °C– 2.34 °C, respectively. Reducing the AV by 0.25 m/s increased the FATR by approximately 20%. Simulations show that the system achieves over 80% comprehensive energy savings in cold and severe cold regions. The findings support system design optimization, operation control, and engineering applications.

Shittu, H. A., Adamu, B. I., Kareem, M. A., Ibrahim, A. S., Abdullahi, F., Aliyu, S. M., *et al.*

Performance enhancement strategies in transition metal dichalcogenides (MX₂) gas sensors: Structure, morphology, mechanism, performance, and real-world applications.

Chemical Engineering Journal, Vol. **549**, (2026)

Two-dimensional (2D) transition metal dichalcogenides (MX₂) have emerged as promising materials for gas sensors, due to their abundant active sites, layered structures, inimitable semiconducting properties, high surface area, and tunable electronic properties. Recent studies revealed that intrinsic MX₂ sensors could not simultaneously achieve high sensitivity, selectivity, speed, and stability without further modification. However, incorporating various strategies could significantly modulate the structural and chemical properties, thereby improving gas-sensing performance through synergistic effects. This review presents a comprehensive, performance-oriented overview based on four sensing parameters: sensitivity, selectivity, response/recovery times, and stability (4S). The influence of charge transport, defect states, phase-dependent properties, and charge-transfer mechanisms is highlighted. Recent advances in performance enhancement through a multidimensional approach, such as morphology design, light-assisted activation, noble metal decoration, heterostructure engineering, plasma modification, and organic compound functionalization, are systematically examined. The influence of these strategies on active sites, adsorption behavior, electronic properties, and interfacial interaction is critically highlighted. Furthermore, the review explores the practical application of these sensors in environmental monitoring, indoor air quality, clinical breath analysis, and food quality assessment. Finally, current challenges and insights into the prospects of MX₂-based gas sensors are discussed.

Mehraban, M. H., Ghansah, F. A., Faraji, S., Zhong, H., Udeaja, C., Mirzabeigi, S.

Physics-informed AI-integrated digital twin framework for early and real-time prediction of mould growth in buildings.

Building and Environment, Vol. **305**, (2026)

Indoor air quality issues, particularly mould and dampness, remain persistent public health concerns in residential buildings despite improvements in building standards and energy performance regulations. In current practice, mould management is largely reactive and relies on occupant complaints and visual inspection after mould has already become visible, at which occupants may have already experienced prolonged exposure to unhealthy indoor environment. To address this limitation, this study proposes a Digital Twin-based framework for continuous monitoring and predictive assessment of mould risk in buildings. The framework combines continuous environmental monitoring using an Internet of Things (IoT) sensor network with a calibrated Building Energy Model (BEM) that synchronizes real-time sensor data with simulation outputs to estimate surface hygrothermal condition across both monitored and unmonitored locations. These hygrothermal conditions are then used to evaluate mould development using the VTT mould growth model. Building upon this physics-based representation of mould dynamics, a Physics-Informed Machine Learning (PIML) model based on Extreme Gradient Boosting is developed to forecast mould growth across prediction horizons ranging from 1 hour to 1 week. The proposed framework was implemented and validated on a sensor-instrumented residential building case study located in Syracuse, New York, achieving high prediction accuracy of up to R² of 0.99 for short-term forecasts and approximately 0.90 for longer horizons up to one-week-ahead mould index prediction. The findings demonstrate reliable prediction of mould development under dynamically changing indoor environment. The framework provides a scalable approach for real-time monitoring and proactive mould risk assessment in new and existing building to improve operation and add a new automated layer for maintenance, enabling early smart decision-making and intervention. For further insight into the proposed framework, methodology, and key findings, an interactive visual summary is available at <https://mehraban.uk/mould-digital-twin>

Ismail, S. A., Ibrahim, M. F., Crüts, B., Rajendiran, S., Mohammad Sham, N., Makhtar, M. M. Z.

[Predicting sick building syndrome using machine learning and epidemiological data for Internet of Thing \(IoT\) Integration.](#)

Asian Journal of Atmospheric Environment, Vol. **20** n°(1), (2026), 19 p.

Sick Building Syndrome (SBS) is a widespread occupational health issue traditionally diagnosed through reactive, subjective symptom questionnaires. This study addresses the critical need for real-time, objective mitigation strategies by developing an automated early warning system to predict multi-categorical SBS risk using machine learning. We conducted a cross-sectional epidemiological study in a Malaysian educational institution, securing a unified dataset from 513 respondents across ten classrooms. Real-time physical environmental parameters and aerosol contaminants, specifically Particulate Matter (PM_{2.5}) and Total Volatile Organic Compounds (TVOC), were captured at a seated breathing zone of 110 cm using high-precision occupational hygiene instruments. This environmental data was synchronized with self-reported health outcomes from a revised MM040NA questionnaire. To address the naturally low prevalence of severe symptoms and mitigate overfitting, our predictive modelling pipeline incorporated a 10-fold stratified cross-validation framework alongside the Synthetic Minority Over-sampling Technique (SMOTE) applied exclusively to training folds. We evaluated five classifiers: Artificial Neural Networks (ANN), Random Forests, Support Vector Classifiers (SVC), K-Nearest Neighbours (KNN), and Logistic Regression (LR), optimizing probability thresholds via the F2-score to prioritize recall. The results demonstrate that General SBS symptoms can be predicted with exceptional sensitivity, with ANN, SVC, and LR models achieving recall rates exceeding 0.90. For predicting the aggregate risk of Total SBS, the distance-based KNN algorithm produced the most balanced F1-score (0.419), serving as a theoretical proof-of-concept for risk clustering. Finally, this research confirms the viability of deploying resource-efficient linear or neural network models onto resource-constrained microcontrollers, providing concrete memory and latency benchmarks for a scalable Internet of Things (IoT) architecture designed for proactive indoor environmental health monitoring.

Zhou, B., Ren, H., Gu, X.-Y., Tan, M.-L., Li, F., Zhuang, C.

[Pressure-constrained coordinated demand-controlled filtration strategy for environmental control in an industrial cleanroom.](#)

Building and Environment, Vol. **305**, (2026)

For industrial product quality, a cleanroom's operational environment is more critical than at-rest, including temperature, humidity, particle concentration, differential pressure, and energy consumption. Traditional DCF strategies adjust FFU flowrate based on particle concentration but often ignore pressure distribution and ceiling panel safety. A field diagnosis in an ISO Class 6 cleanroom and TRNSYS-CONTAM co-simulation revealed the pressure instability mechanism. Three AHU+FFU and two MAU+FFU+DCC control strategies were compared. Results show the dynamic temperature fluctuation 2.4 times and the dynamic particle concentration 3.4 times that under at-rest condition. AHU+FFU airflow mismatch can induce pressure reversal and 105.6 Pa on ceiling panels. The proposed coordinated demand-controlled strategy for MAU+FFU+DCC system maintained the maximum differential pressure across the ceiling blind panel at 4.5 Pa, ensured good air cleanliness level and reduced energy by 49.2 %, which enhanced safety, stability, and energy efficiency.

Sanchez, N., Maldonado, J., Aguilar, N.

[Prototyping a Synergistic Multi-Band UV Device to Enhance the Indoor Air Quality of Hospital Environments.](#)

LACCEI, Vol. **1** n°(14), (2026)

People spend approximately more than 90% of their time indoors, which exposes them to airborne gaseous and chemical pollutants that can affect their health and well-being. Recent studies have shown that up to

63% of healthcare personnel present at least one health issue associated with poor indoor air quality. Consequently, this study evaluated various existing technologies aimed at improving indoor air quality. Based on the collected information, a synergistic multi-band prototype was developed, harnessing the germicidal efficacy of UV-C light and the photocatalytic effect generated by exposing titanium dioxide to UV-A light. Several tests were conducted under three different experimental scenarios: no intervention, UV-C intervention, and UV-C + photocatalysis intervention. The prototype achieved reductions of 86.19%, 81.68%, and 69.87% in volatile organic compounds, and 100% elimination of aerobic bacteria and yeasts when applied in various hospital environments. The data obtained was subjected to rigorous statistical analysis, demonstrating significant differences ($p < 0.0001$) among each of the experimental scenarios.

Elankavi, R., Naseem, F., Akhtar, M. S., Qaisar, M. A.

[Reimagining Hotel Operations in the Age of Artificial Intelligence Through the StayMaster Smart Platform.](#)

International Conference on Cognitive Computing, AI & Data Intelligence (IC3AID 2026). Chennai, India, July 30-31, 2026

AI is transforming hotel operations at a rapid pace, necessitating management systems that are intelligent, flexible, and interconnected. This study unveils the StayMaster Smart Platform, an AI-driven innovation that revolutionizes energy savings, cleaning coordination, maintenance, and front desk administration through guest experience customisation. Visualizing the platform's architecture, documenting its primary functional components, and demonstrating how automation, ML, and real-time data analytics enhance operational agility and evidence-based decision-making are all part of design science research. Sustainable resource management, operational efficiency, service consistency, and cross-departmental cooperation are all enhanced with StayMaster. In addition to AI, the study broadens platform-based intelligence in the hospitality industry. Smart hotel platforms are supported by the research, which also helps with digital transformation for management. The topics of data-driven hotel management and artificial intelligence strategy in the hospitality industry are both covered in depth in this study.

Aşçı, Y. S., Lalikoğlu, M., Baş, Y., Altunkaya, A. N.

[Smart Sensors, AI, and IoT for Environmental and Biomedical Intelligence.](#)

In: Global Digital Health Transformation: AI, Policy, and Clinical Innovation. IGI Global Scientific Publishing; 2027. 141–174 p.

his book chapter examines the role of chemical and biological sensors in advancing modern healthcare and public health systems. It highlights how global health challenges, intensified by factors such as urbanization, environmental changes, and the COVID-19 pandemic, have accelerated the demand for rapid, real-time, and accessible monitoring technologies. The chapter outlines the fundamental principles of chemical and biosensors, including their components, classification, and working mechanisms. It further explores current applications across healthcare, environmental monitoring, wastewater analysis, air quality assessment, agriculture, and food safety, emphasizing their contribution to continuous and non-invasive data generation. The integration of sensor technologies with digital health systems, the Internet of Things (IoT), and data analytics is discussed as a key driver for early warning and predictive health strategies. Overall, the chapter presents sensor technologies as essential tools for enabling proactive, data-driven, and scalable approaches to public health management.

Ru, X., Wan, H., Yin, M., Wang, M.

[Source-pathway-aware early prediction of 28-day room-scale formaldehyde concentration responses from wood flooring systems.](#)

Journal of Building Engineering, Vol. **132**, (2026)

Formaldehyde released from wood flooring affects indoor air quality, but room-scale responses depend on material–installation source pathways and environmental boundaries. This study developed a source–pathway-aware framework to predict 28-day room-scale formaldehyde responses from the first 168 h of monitoring. Material structure, installation features, room-boundary and background conditions, and early concentration trajectories were encoded as source–response descriptors in a Material-aware Source–Response Mixer (MSR-Mixer). The framework was developed using 55 experimental units under a standardized single-zone room boundary. After the model architecture, inputs, screening threshold, Top-5 rule, and prediction-interval procedure were locked, 20 newly tested challenge-enriched units were used for prospective same-laboratory validation; 12 representative units were additionally monitored for 90 days. MSR-Mixer achieved RMSEs of 0.0129, 0.0126, and 0.0128 mg m⁻³ for 336 h, 672 h, and 216–672 h trajectory prediction, respectively. The predicted Top-5 captured four of the five highest observed response-score units, six of seven screening-defined high-response units were correctly identified, and 90% prediction intervals covered 18 of 20 validation units. A separate four-room perturbation experiment showed that exposed plywood-core edges and reduced ventilation substantially increased 336 h concentrations; the exposed-edge/low-ventilation condition fell outside the model's 90% prediction interval, defining an applicability boundary. Seam and cut-edge exposure, long joints, and adhesive-related systems were high-response pathways, whereas exposed plywood-core edges and underlayment-enhanced configurations represented extrapolation boundaries. The 90-day check confirmed stable high/low separation with local ordering shifts among medium-response systems. These findings support early source-control decisions and continued-testing prioritization.

Sauvé, J. F., Emili, A., Savary, B., Mater, G.

[Un outil d'aide à l'évaluation de l'exposition aux aérosols et autres agents chimiques et biologiques.](#)

39ème Congrès Français sur les Aérosols (CFA2026)

L'INRS a mis en ligne en 2023 un outil (disponible depuis <http://www.inrs.fr/outil110>) fournissant des informations descriptives sur les niveaux d'exposition dans l'air par situation de travail pour 626 substances chimiques dont des aérosols et des composés organiques volatils. Dix variables dont la tâche, le secteur d'activité et la présence de dispositifs de captage permettent de caractériser des situations de travail. Ces informations sont tirées de la base de données Colchic qui enregistre les mesures d'exposition en milieu de travail depuis 1987. Une évolution de l'outil en 2025 a permis d'y intégrer des informations correspondant à 19 agents biologiques (bactéries, moisissures, toxines) à partir de 13 182 mesures d'exposition. Initialement conçu pour faciliter la démarche d'évaluation des risques professionnels, cet outil constitue également une source d'information utile pour orienter les activités de recherche sur les aérosols potentiellement retrouvés en milieu de travail.

De Coster, G., Demeestere, K., Van Langenhove, H., Walgraeve, C.

[Untargeted analysis of volatile organic compounds in indoor air: uptake rate determination on passive samplers and application in museum-depot units.](#)

Building and Environment, Vol. **306**, (2026)

In recent decades, awareness has increased in the cultural heritage field about the presence and impact of volatile organic compounds (VOCs) in indoor museum environments, given their impact on both human health and heritage objects. These VOCs can be collected using passive air samplers; however, reliable application of this approach depends on compound- and sampler-specific uptake rates (UTRs), which remain scarce in literature. Therefore, the scope of this study was twofold. First, 7-day experimental UTR_{exp} were determined by parallel active and passive sampling on Tenax TA axial sampling tubes. An in-depth untargeted screening resulted in a total of 92 UTR_{exp} of VOCs from different chemical classes.

Secondly, these UTRsexp were used to quantify VOCs throughout the museum storage facility (at 23 sampling locations). Total VOC (TVOC) concentrations ($n = 77$ VOCs) ranged from $602 \mu\text{g}/\text{m}^3$ up to $3389 \mu\text{g}/\text{m}^3$ (average $2156 \pm 702 \mu\text{g}/\text{m}^3$), thereby exceeding the Belgian indoor intervention value ($1000 \mu\text{g}/\text{m}^3$) in nearly all samples. Headspace analyses of building materials revealed that the epoxy floor is the main source of the most abundant VOCs (i.e. benzyl alcohol and benzaldehyde), as well as a substantial number of other VOCs, including a wide range of C3- and C4-benzene substituted compounds. To the best of our knowledge, this represents one of the most extensive datasets on diffusive UTRsexp in indoor settings to date, contributing valuable data to an area where information is currently limited. Additionally, this work offers a unique dataset on air quality within a museum storage facility in Belgium.
