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FaradaIC®
World's smallest electrochemical gas sensor

faradaic.com

SMART LOGISTICS

Manipulation free Intelligent Data Tracking

Logistic & Supply Chain

Intelligent Data Tracking with the World‘s First Oxygen Sensor on a Chip

Smart logistics and supply chain management leverage advanced technologies such as IoT, AI, and real-time data analytics to enhance efficiency, reduce waste, and ensure the quality of goods throughout their journey. These systems enable precise tracking, predictive maintenance, and dynamic decision-making, offering businesses and consumers unparalleled transparency and reliability.

A key innovation in this field is oxygen sensing, a critical tool for monitoring the atmospheric conditions of perishable goods like food and pharmaceuticals. Oxygen sensors provide real-time data on oxygen levels within packaging or storage environments, ensuring optimal conditions to preserve product freshness and prevent spoilage. By integrating oxygen sensing into smart logistics, businesses can enhance supply chain resilience, improve product quality, and minimize losses, meeting the demands of modern markets while reducing environmental impact.

Using IoT devices equipped with oxygen sensors in logistics and supply chain management provides several key advantages, especially for perishable goods. These benefits improve operational efficiency, reduce waste, and ensure product quality and safety. Here are the primary advantages:

1. Real-Time Monitoring of Product Environment

- Advantage: IoT devices with oxygen sensors provide continuous, real-time data on oxygen levels within storage or transport containers.
- Impact: Ensures that controlled atmosphere conditions are maintained, protecting products from spoilage or contamination.

2. Improved Shelf Life Management

- Advantage: Monitoring oxygen levels helps maintain optimal conditions to slow down spoilage and microbial growth.
- Impact: Products arrive at their destination in the best possible condition, with extended shelf life, reducing waste.

3. Enhanced Supply Chain Visibility

- Advantage: IoT devices transmit oxygen data to cloud-based platforms, offering visibility across the supply chain.
- Impact: Stakeholders can track and verify that products are stored and transported under the required conditions, increasing transparency and accountability.

4. Automated Alerts and Issue Mitigation

- Advantage: IoT systems can send automatic alerts if oxygen levels deviate from acceptable ranges, indicating leaks or system failures.
- Impact: Allows for immediate corrective actions to protect the product, minimizing losses and ensuring food safety.

5. Optimized Inventory Management

- Advantage: Accurate oxygen monitoring data helps predict product freshness and shelf life.
- Impact: Enables better inventory rotation and planning, reducing overstocking or wastage of perishable goods.

6. Reduced Costs Due to Fewer Spoilage Incidents

- Advantage: Precise control of oxygen levels ensures that spoilage rates are minimized during transportation and storage.
- Impact: Reduces the financial impact of product losses and claims for damaged goods.

7. Better Quality Assurance

- Advantage: Consistent monitoring of oxygen levels ensures that products meet quality and safety standards throughout the supply chain.
- Impact: Builds consumer trust and helps brands comply with regulatory requirements.

8. Predictive Maintenance for Packaging and Storage

- Advantage: IoT devices can identify trends in oxygen level fluctuations that indicate packaging defects or equipment issues.
- Impact: Prevents costly failures by enabling proactive maintenance of storage and transport systems.

9. Data-Driven Decision Making

- Advantage: Aggregated data from IoT devices provides insights into supply chain performance and environmental conditions.
- Impact: Helps businesses optimize routes, packaging, and storage solutions based on historical and real-time data.

10. Compliance with Regulatory Standards

- Advantage: Continuous oxygen monitoring ensures that conditions comply with regulations for transporting sensitive goods, such as food or pharmaceuticals.
- Impact: Avoids penalties, enhances safety, and supports documentation for audits.

11. Increased Efficiency in Multi-Modal Transport

- Advantage: IoT-enabled oxygen sensors can monitor conditions across different transportation modes (air, sea, land) and provide seamless updates.
- Impact: Ensures product integrity is maintained regardless of the logistics chain’s complexity.

12. Support for Sustainability Goals

- Advantage: By reducing spoilage and waste through precise oxygen monitoring, IoT devices support sustainable logistics practices.
- Impact: Decreases the environmental footprint and aligns with corporate sustainability initiatives.

By integrating IoT devices with oxygen sensors into logistics and supply chain operations, companies can improve product quality, reduce costs, and enhance overall efficiency, ensuring that goods are delivered safely and in optimal condition.

Oxygen sensors with MECS-Technology® from FaradaIC set new standards for freshness monitoring in controlled and modified atmospheres and predict shelf life more accurately.

This not only benefits consumers, but also reduces waste and consolidates the position of producers as pioneers in this field. Together, we can revolutionise the way the world approaches the storage of fresh produce and contribute to a more sustainable and efficient future for the industry.

Micro electrochemical sensors from FaradaIC are sensors with MECS-Technology® and complex systems that utilise chemical reactions to detect and quantify gas concentrations. These sensors work on the principle of measuring electrical currents generated by reactions related to gas concentration, providing accurate and fast measurement of gas concentration. Due to their novel chemical structure, they do not dry out like other electrochemical sensors and can therefore also be used in dry environments with 0% relative humidity and industrial temperature ranges of up to 85 °C. The structure is similar to that of MEMS (Figure 1) and is optimized for use in high-volume applications.

For high-volume production, MECS-Technology based sensors can leverage from existing MEMS fabs and porcesses. This enables a fast ramp-up into high volume applications and designs, that have not been possible with conventional electrochemical sensors before.

Additional integration into RFID or micro controllers with the use of mixed signal ASICs will also be possible.

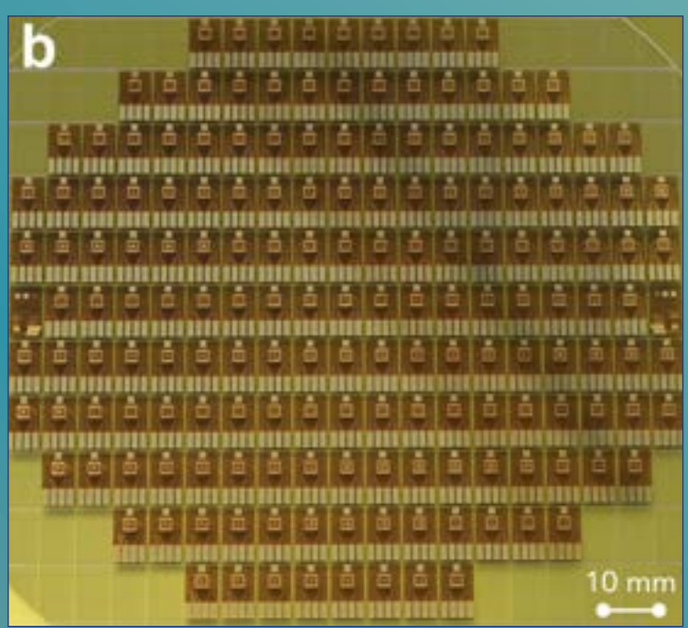

Figure 1: Multiple electrochemical sensors on a single wafer utilizing MECS-Technology®

Figure 2: World's smallest oxygen sensor

Our sensors can be integrated into bags and packages, enabling users to track and monitor the food condition inside during transportation and storage in real time.

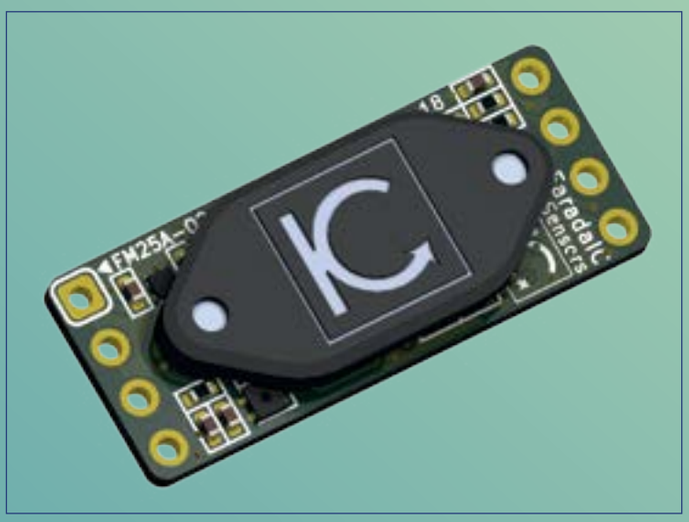

Figure 3: Smart digital oxygen gas measuring module

The differences between FaradaIC's MECS-Technology® and other gas sensing technologies can be seen in Figure 7. Miniaturizing the electrochemical gas sensor onto a chip, the most desired features can be combined onto a single platform.

By incorporating our sensors into bags and packages which are stored in a warehouse, our customers can set new standards for freshness monitoring in controlled and modified atmospheres. At the same time, any change in the atmosphere inside of the bags is monitored. Additionally, our MECS-Technology® can easily be integrated into BLE (Bluetooth® Low-Energy) based real-time location systems (RTLS), locating each and every sensor together with the freshness status of the packaged food, also indicating any change or package manipulation.

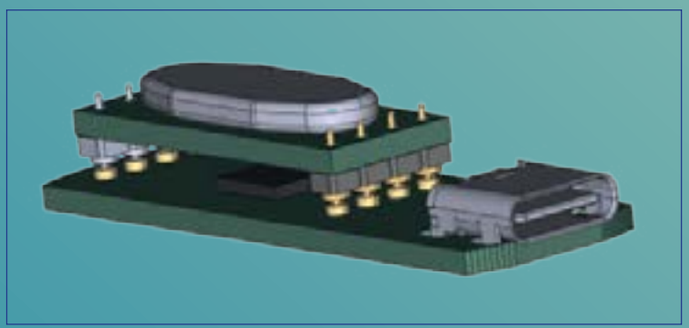

Figure 4: Smart data device with Bluetooth® BLE or USB interface from x-log Elektronik GmbH

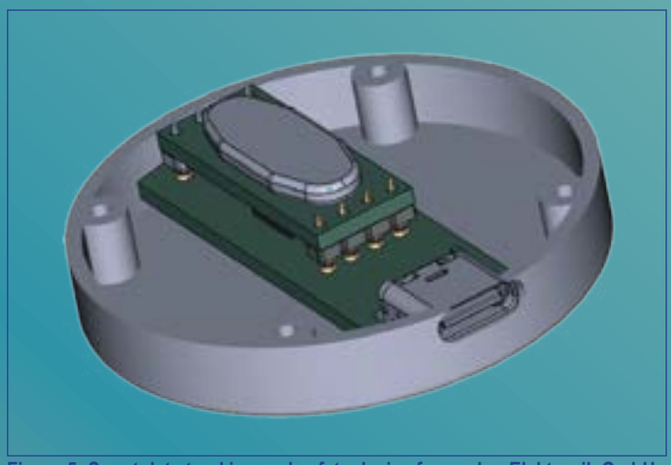

Figure 5: Smart data tracking and safety device from x-log Elektronik GmbH

With the latest improvements in BLE technologies and data transfer into cloud systems, freshness monitoring with location tracking becomes the perfect combination to transfer sensor data together with their location to the cloud via mesh networks. There, the data is analysed and forwarders can determine the best time of sales for each individual packages and bringing them to the point of sales.

Asset tracking is already a requirement in warehouse systems, and the new BLE technologies enable simultaneous data transmission from inside bags and even through food and packaging, providing many real-time benefits such as;

- Detailed condition monitoring with real-time localisation.
- General gas monitoring in bags and packages.
- Adding full transperancy in packaging and logistics processes.
- Imidiately identify damaged or manipulated packages.
- Improved Quality management.
- Alerts when gas concentration limits have exceeded.
- Shelf life prediction for each single package.
- Finding the bags with best time of sale.
- Licensing complete packaging system.
- Recalibration of sensors via the network.

Figure 6: Storage of MAP bags with best-in-and-best-out system

Technology	MECS-Technology® Micro Electro Chemical Systems	MOX Metal- Oxide	Infrared NDIR for non dispersive gases	Electrochemical	Photoacoustic
Miniaturized	✓	✓	⊗	⊗	⊗
Cost-effective	✓	✓	⊗	⊗	⊗
Selective	✓	⊗	✓	✓	✓
Ultra-low power	✓	⊗	⊗	✓	✓
High volume manufacturing	✓	✓	⊗	⊗	✓

Figure 7: Gas sensors: Technology comparison