Electro Optical Components, Inc.
5464 Skylane Boulevard, Suite D, Santa Rosa, CA 95403
Toll Free: 855-EOC-6300
www.eoc-inc.com | info@eoc-inc.com

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ANTI TAMPERING

Manipulation free anytime and anywhere with the World‘s First Oxygen Sensor on a Chip

As the complexity and interconnectivity of modern systems continue to evolve, safeguarding devices and data against tampering has become a critical priority for engineers and designers across industries. Tampering, whether physical, digital, or a combination of both, poses a significant risk to device integrity, operational safety, and intellectual property. Anti-tampering solutions are essential to protect sensitive information, maintain device functionality, and ensure regulatory compliance in applications ranging from food to consumer electronics and industrial equipment to defense systems and medical devices.

Our technologies enables new methodologies, and technologies for implementing effective anti-tampering measures. By addressing potential vulnerabilities and adopting robust design strategies, engineers can mitigate risks and build trust in their systems.

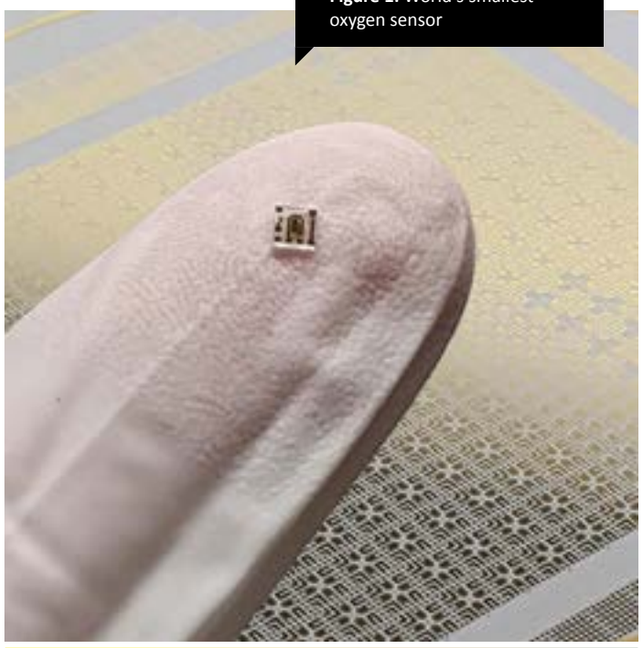

Figure 1: World's smallest oxygen sensor

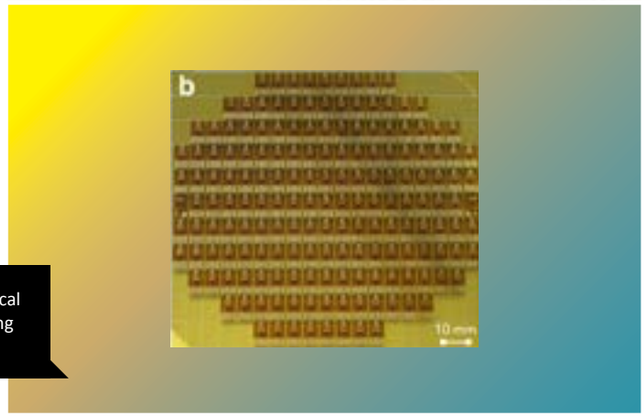

Figure 2: Multiple electrochemical sensors on a single wafer utilizing MECS-Technology®

Anti-Tampering together with our technology provides the following advantages

- Enhanced Security: Anti-tampering sensors help detect unauthorized access, manipulation, or interference with systems or devices, ensuring the integrity and security of sensitive operations.
  Real-Time Alerts: These sensors provide instant notifications in case of tampering attempts, enabling quick responses to prevent potential damage, theft, or breaches.
- Protection of Critical Data: By safeguarding devices and systems, anti-tampering sensors help secure sensitive information, preventing data breaches or unauthorized modifications.
- Increased Trust and Reliability: Implementing anti-tampering measures enhances the credibility of systems and products, building trust among consumers and stakeholders.
- Regulatory Compliance: Many industries require tamper-proof systems to comply with legal and safety regulations, especially in sectors like food, pharmaceuticals, and financial services.
- Extended Product Lifecycle: Anti-tampering sensors can reduce the risk of damage caused by tampering, helping to maintain product integrity and extending its operational life.
- Improved Quality Assurance: These sensors ensure that products and systems remain unaltered during manufacturing, transportation, or usage, maintaining consistent quality.
- Reduced Losses and Costs: By preventing theft, sabotage, or damage, anti-tampering sensors minimize financial losses and repair costs associated with such incidents.
  In summary, anti-tampering sensors provide robust security, protect valuable assets, and improve the overall safety and efficiency of operations across various industries

Our Faraday-Ox® (Figure 3) is the first oxygen measuring module of its kind, fully digital and factory calibrated for easy integration into IoT devices (Figuers 4 and 5).

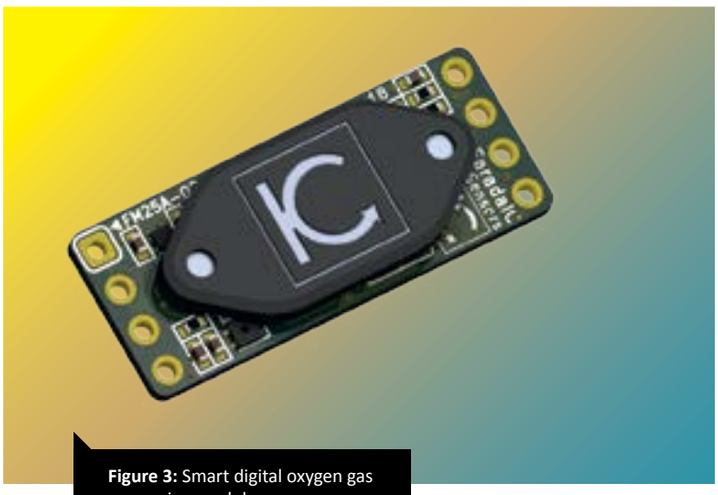

Figure 3: Smart digital oxygen gas measuring module

The MECS-Technology® from FaradaIC also addresses specific challenges in many industries:

1. PHARMACEUTICAL INDUSTRY:

- Counterfeit Medications: Preventing tampering with packaging or supply chain to avoid counterfeit drugs reaching consumers.
- Regulatory Compliance: Ensuring sensors meet strict guidelines like FDA or EU standards for tamper-evident packaging.
- Environmental Sensitivity: Designing tamper-resistant solutions that can withstand varying storage conditions (e.g., cold chain logistics).

2. FOOD AND BEVERAGE INDUSTRY:

- Product Freshness: Ensuring tamper-proof packaging does not compromise the quality or shelf life of perishable items.
- Cost Constraints: Balancing anti-tampering measures with the cost-effectiveness of packaging for mass production.
- Consumer Trust: Visible tamper-evidence must be user-friendly while providing robust protection against adulteration.

3. FINANCIAL AND BANKING INDUSTRY:

- Data Security: Protecting devices like ATMs and payment terminals from tampering aimed at stealing sensitive information (e.g., card skimming).
- Remote Monitoring: Ensuring real-time alerts for tampering attempts in geographically distributed systems.
- Resilience: Anti-tampering measures must be robust enough to prevent physical breaches without disrupting functionality.

4. ELECTRONICS AND IOT DEVICES:

- Miniaturization: Developing anti-tampering mechanisms suitable for compact and portable devices.
- Cybersecurity: Preventing tampering with firmware or hardware that could compromise device security.
- Power Efficiency: Ensuring tamper sensors do not drain device battery life unnecessarily.

5. AEROSPACE AND DEFENSE INDUSTRY:

- Extreme Conditions: Anti-tampering solutions must perform reliably in extreme environments, such as high pressure or temperature.
- Mission-Critical Security: Tamper-proof systems are essential to ensure the integrity of navigation, communication, and surveillance equipment.
- Complexity: Adapting solutions to highly specialized and sensitive equipment can be challenging.

6. RETAIL INDUSTRY:

- Theft Prevention: Securing products from tampering or theft while maintaining an aesthetically pleasing and accessible design.
- Supply Chain Transparency: Ensuring tamper-evidence throughout logistics to avoid fraud or contamination.
- Scalability: Implementing cost-effective anti-tampering solutions for large inventories.

7. ENERGY AND UTILITIES INDUSTRY:

- Infrastructure Protection: Preventing tampering with meters, pipelines, and equipment in remote or high-risk areas.
- Data Accuracy: Ensuring tamper-resistance for energy meters to prevent fraud and unauthorized consumption.
- Durability: Solutions must withstand harsh outdoor conditions and attempts at physical interference.

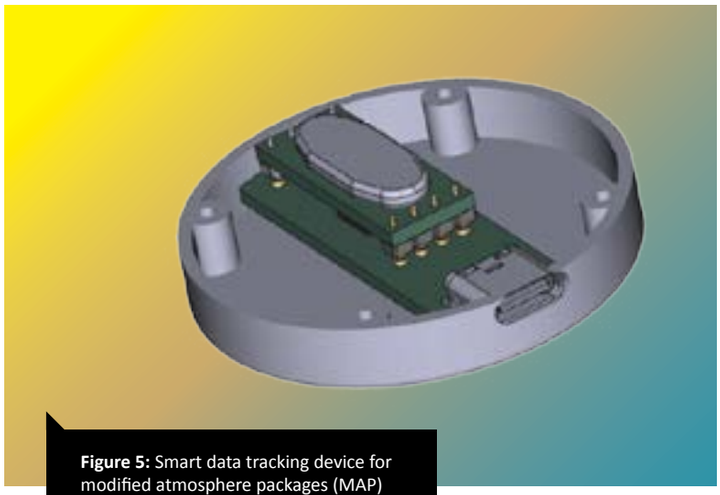

Figure 5: Smart data tracking device for modified atmosphere packages (MAP) from x-log Elektronik GmbH

Each industry faces unique technical, environmental, and regulatory challenges in implementing effective anti-tampering measures, requiring tailored solutions to address their specific needs.

By enabling precise control and monitoring of oxygen levels, oxygen sensors significantly reduce the risks of spoilage, contamination, and degradation, making them indispensable in CA packaging for food safety.

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. (Figure 2)

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.

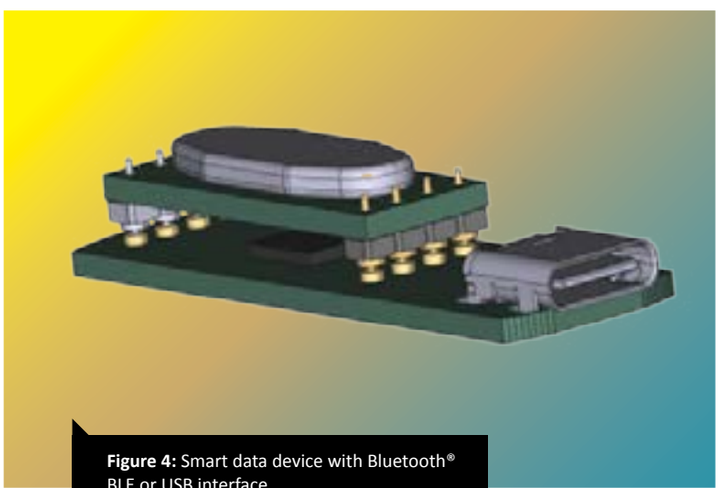

Figure 4: Smart data device with Bluetooth® BLE or USB interface from x-log Elektronik GmbH

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.

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. (Figure 6)

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
- Alert if content or condition has changed
- Alert 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