

Breath Analysis with Electrochemical Sensors



IT Dr. Gambert GmbH

Sensor
Manufacturer

Private +
Independent

Annually Growth
> 20%



Development

High Performance Sensors
Multidisciplinary Team

Production

Outstanding Quality
Flexibility

Mission

Intellectual Property

> 15 Patents

Sales

International Certifications
Excellent Customer Support

Milestones

First electrochemical
NO-ppb sensor

First lead-free
galvanic oxygen sensor

Fastest electrochemical
oxygen sensor

Long life sensors for
emmission control

H₂S Sensor with widest
measurmemnt range for
biogas measurements

ppm oxygen sensors

Comparison of Techniques for Breath Analysis

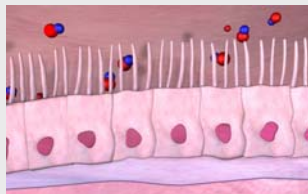
Technique	Breath by Breath	Main-stream	Clinical Use	Size/ Weight	Interference by Humidity	Price
Paramagnetic	+	-	+	-	+/-	-
Optical Analysis	+	+/-	+	-	+/-	-
Mass Spectrometry	+	-	-	-	+	-
Raman Scattering	+	-	-	-	+	-
Electrochemical Sensor	+	+	+	+	+	+

+ possible/advantageous

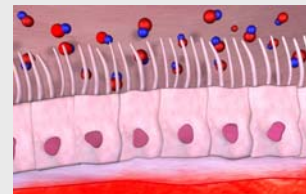
- impossible/disadvantageous

NO in the airways

- is an endogeneous regulator (e.g. peripheral blood flow, immunreactions, neurotransmitter)
- was first reported in exhaled breath in 1991
- 1993 it was proven that NO in exhaled air is elevated in patients with asthma
- reason for increased concentration in breath is inflammation



normal epithelial cells
minute release of NO



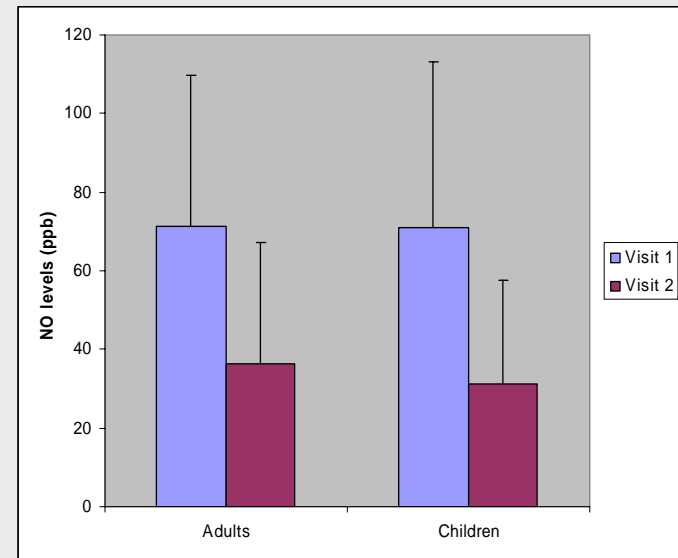
inflammed epithelial cells
increased production of NO

Asthma and NO in exhaled air

- Asthma is a chronic inflammatory process, leading to airflow limitation and increased responsiveness to various stimuli
- In Germany in 5% of the adults and 10 % of the children, 5000 deaths annually
- Diagnosis and therapy today rely on symptoms (lung function tests) or on invasive methods (biopsies, bronchoalveolar lavage)
- Measurement of NO in exhaled air makes a non invasive monitoring of the inflammation possible
- As meaningful as biopsies

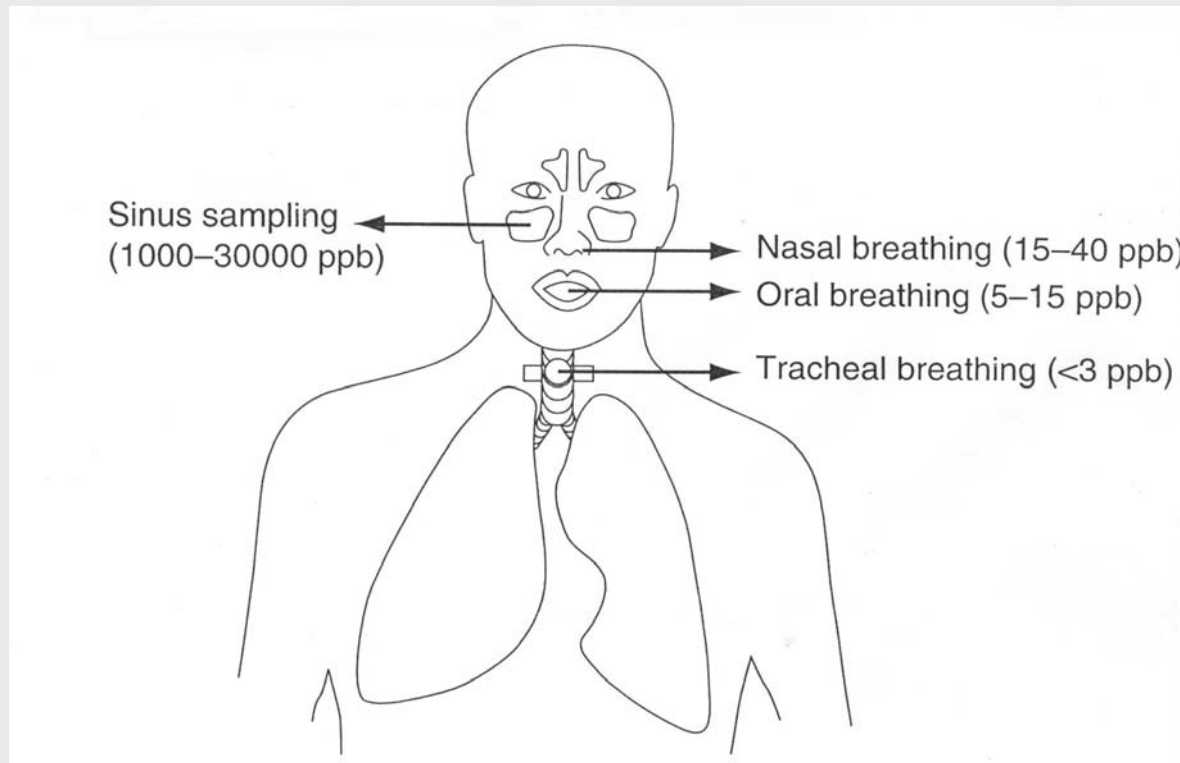
Asthma and NO in exhaled air

- Correct asthma diagnosis
- Shows response to steroids, their efficiency and the compliance of the patient
- Less medication and less acute exacerbations with NO monitoring (cost saving)
- Results are available instantly



NO values before and after intake of steroids (Silkoff et al, JACI 2004)

Concentration of NO in the airways



Guide to interpretation of Fe_{NO} values in patients with airway disease

Do not use this guide if patient is a smoker. Data are inconclusive for current smokers.
NOTE! Fe_{NO} values are complementary to spirometry values.

Fe _{NO} (ppb)*	LOW	NORMAL	HIGH NORMAL/INCREASED	HIGH
Adult	< 5	5–20	20–35	> 35
Paediatric <12 years	< 5	5–15	15–25	> 25
	<p>Suspicious – May require investigation</p> <p>Possible Causes:</p> <ul style="list-style-type: none"> – Primary ciliary dyskinesia – Cystic fibrosis – Bronchopulmonary dysplasia 	<p>Eosinophilic inflammation is unlikely</p>	<p>Maybe eosinophilic inflammation – May require further investigation</p> <p>Moderately raised Fe_{NO} may indicate underlying inflammation, but note that: – Cold and influenza can raise Fe_{NO} – Some patients have higher baseline Fe_{NO} levels</p>	<p>Highly indicative of ongoing eosinophilic inflammation. Symptomatic patient likely to respond to steroids</p> <p>Possible Causes (if already on steroids):</p> <ul style="list-style-type: none"> – Poor compliance with steroid therapy – Recent allergen exposure – Steroid dose inadequate – Steroid resistance <p>NOTE! Not all patients with high Fe_{NO} values display symptoms</p>

This guide has been reviewed by leading experts with experience in exhaled nitric oxide measurement application. For references and information of exhaled NO in asthma see the Scientific Background – Exhaled Nitric Oxide in Asthma, issued by Aerocrine.

*At 50 ml/s flow rate

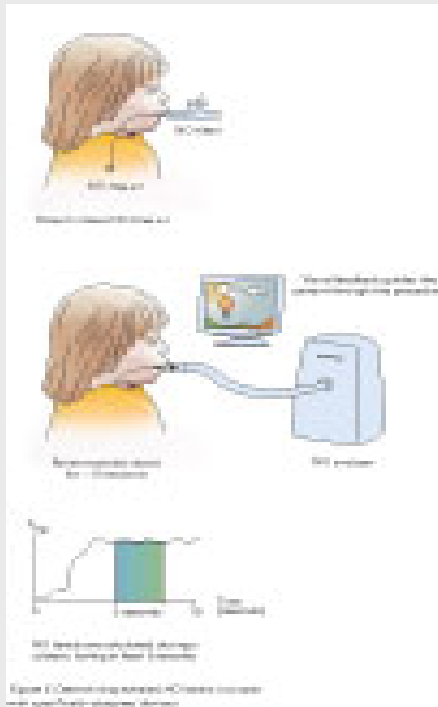
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Aerocrine – Improving management and care of patients with inflammatory disorders

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Measurement of NO in the clinic



Measurement of NO in the doctors office

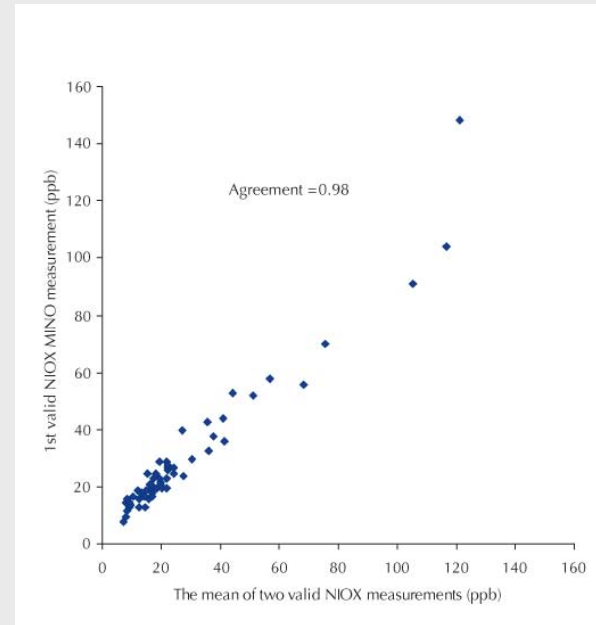
- Small, light weight, portable
- Simple handling for physician and patient
- No calibration necessary
- For the doctors office or home care
- For adults and children
- Accurate and reproducible



Electrochemical NO Sensor

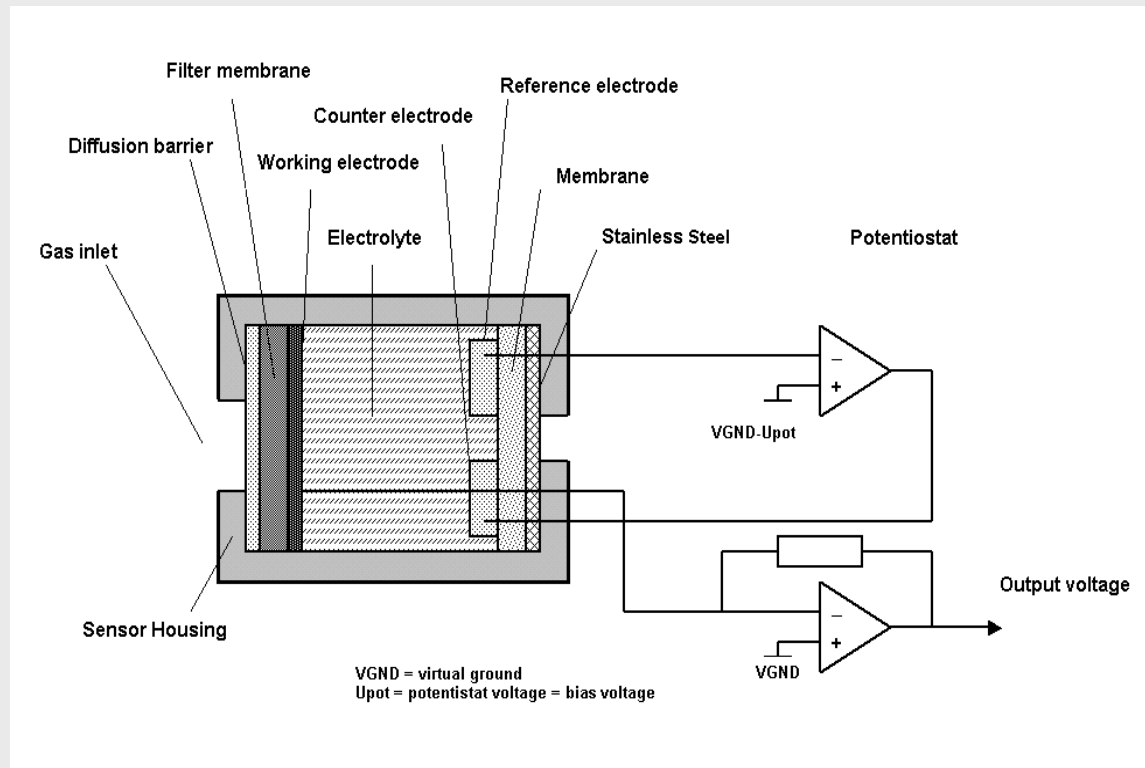


Electrochemical NO Sensor

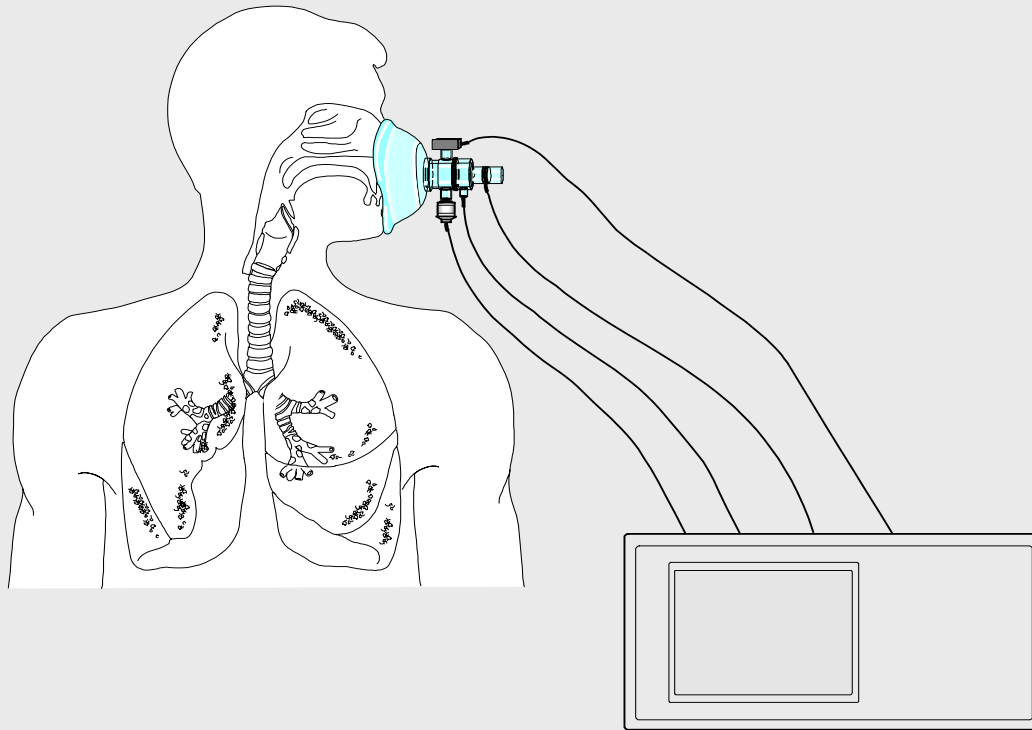


Agreement electrochemical Sensor/Chemiluminescence

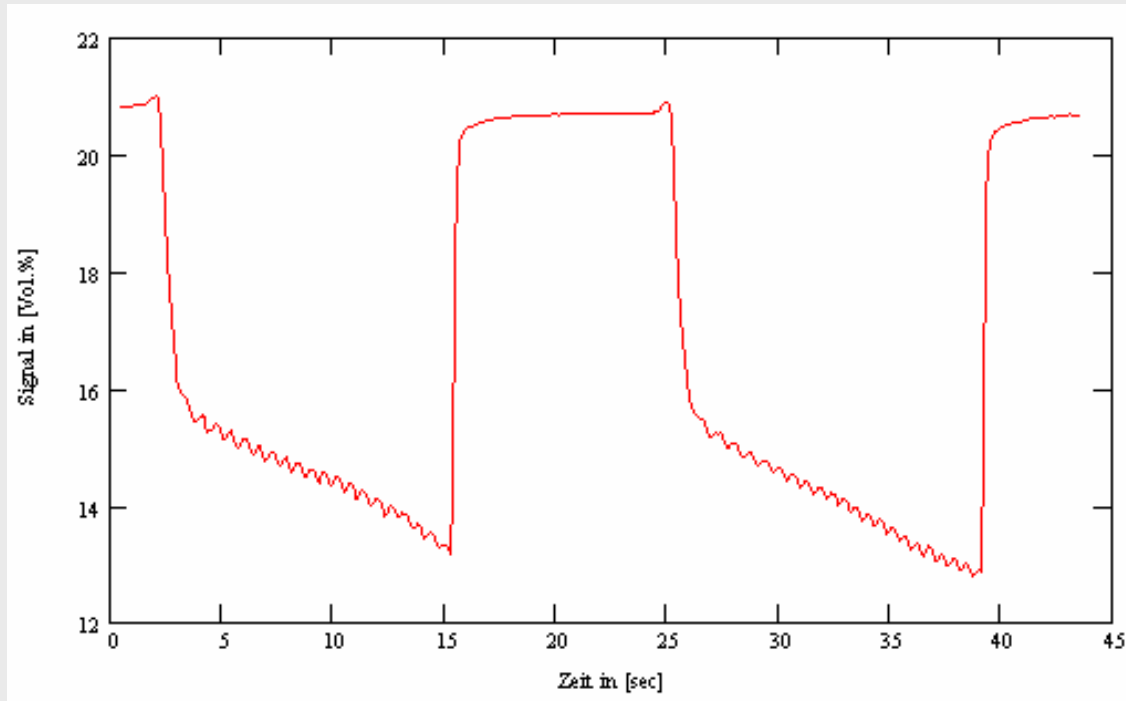
Electrochemical NO Sensor



Sampling system with fast oxygen sensor



Breath curve with fast oxygen sensor



Applications of Breath by Breath Oxygen Measurements

Oxygen Measurement only

Pulmonary Testing

Mechanical Ventilation

Inspiratory pO_2

End-Tidal pO_2

Pulse Rate

Sports Medicine

Oxygen Uptake/Consumption

Energy Consumption/Metabolism

Oxygen and CO_2 combined

Respiratory Quotient

Anaesthesia

Combination with other Parameters

Cardiac Output

Calorimetry

Spirometry

Literature

- NO:** Ricciardolo FLM et al. Nitric oxide in health and disease of the respiratory system. *Physiol Rev* 84: 731-765, 2004
- Oxygen:** US 6,699,202 Method and device for physiologic analysis, IT Dr. Gambert GmbH