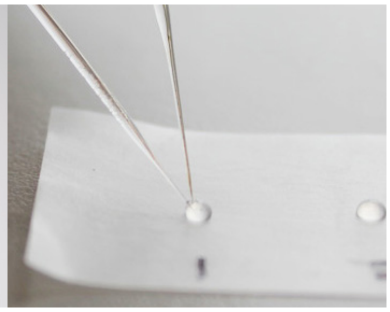
ENABLING

MICROSCALE

RESEARCH



Biomedical applications

Microsensors used in e.g.:

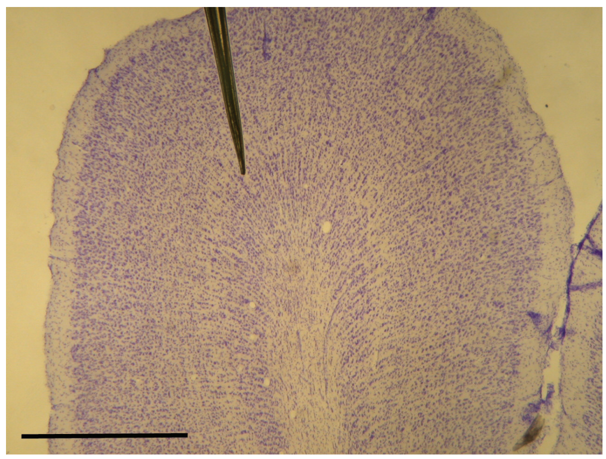
- Neuroscience
- Liver and kidney research
- Cerebral blood flow
- Diabetes
- Plastic surgery
- Rhinology
- Cell signaling
- Microbiology

Brain oxygen measurement

Offenhauser et al. (2005) used tiny (5 µm) oxygen microsensors to study the coupling of neural activity and localized oxygen consumption in rat cerebral cortex tissue.

The authors found a relationship between the cerebral blood flow and the tissue oxygen tension, suggesting the presence of a tissue oxygen reserve.

Unisense can make oxygen microsensors with a tip size as small as 3-5 microns. This enables the insertion of the sensors into soft living tissue like the brain in vivo.

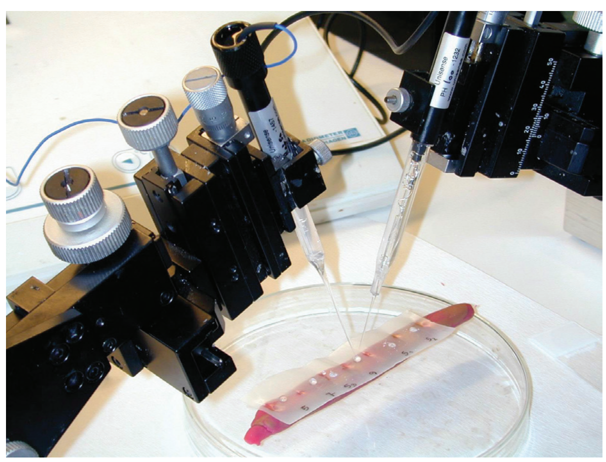


Composite picture showing an oxygen microsensor inside brain tissue.
Courtesy Dr. Jeff Thompson

Measurements in small volumes of liquid (> 4 µl)

Due to the extremely small dimensions of the microsensors (down to 2µm), they are suitable for measuring in very small sample volumes down to a few microlitres.

The picture shows how pH is measured in a droplet (4 µl) of dissolved drug. The electrode to the left is a Unisense micro reference electrode, and the electrode to the right is a Unisense pH sensor. Both sensors are held by micromanipulators mounted on laboratory stands to stabilize the set-up. The signal from the sensor is read on a millivoltmeter.



Measuring pH in tiny droplet of dissolved drug.

Studying oxygen conditions of in vitro cell cultures

The respiration of a cell culture combined with the low diffusion rate of oxygen in the growth medium can lead to a marked decrease in oxygen tension close to the cells.

Using a custom-built profiling set-up, the oxygen consumption of a carcinoma cell monolayer was studied. The measurements showed a highly reduced pericellular oxygen concentration (Fig. 1). The oxygen gradient through the growth medium was also measured, allowing consumption rates to be calculated directly from the provided data acquisition software utility. In Fig. 1 the oxygen utilization rate is 360 fmol O_2/cell/h.

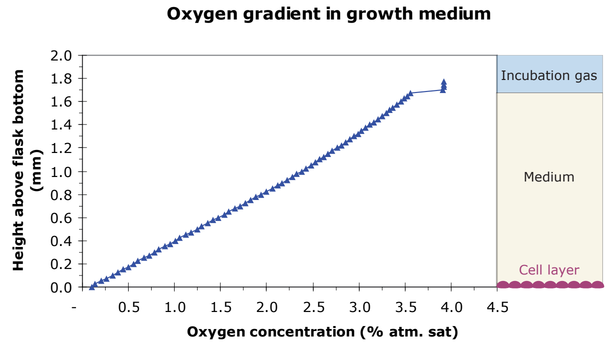


Figure 1. Oxygen gradient in a culture flask with human carcinoma cells. Notice how the cells' oxygen consumption reduce the concentration from 3.9% in the gas phase to 0.1% at the flask bottom. Measurements were made every 25 µm.

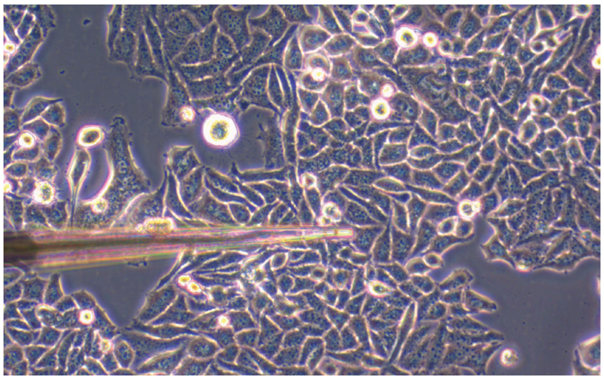


Figure 2. The tip of the microsensor touching the cells.

The setup was mounted on an inverted microscope and controlled by a motorized micromanipulator, tilted at an angle.

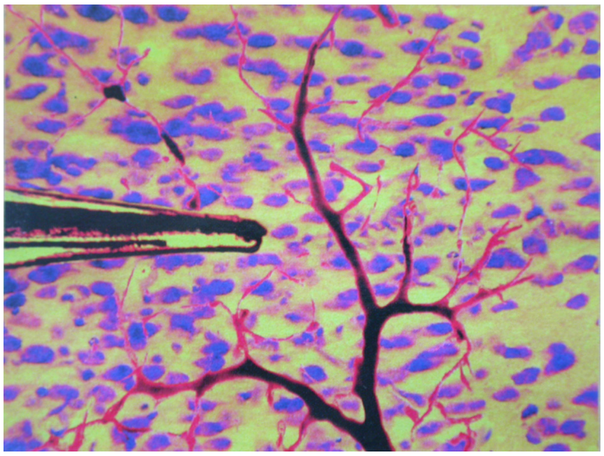
For details on this application, please see our website or contact us directly.

References:
Pettersen, E.O., et al. 2005. Cell Prolif. 38 (4), 257–267.
Metzen E, et al. 1995 Respir. Physiol. 100(2):101-6.
Wolff M, et al. 1993. Am. J. Physiol. 265(5 Pt 1):C1266-70.

Single-neuron activity and tissue oxygenation

Based on a specific customer request, Unisense developed a combined microsensor for measuring oxygen tension and action potentials simultaneously. The sensor - called an APOX sensor - was first used in a study of the cerebral cortex where single neuron neural activity and oxygen consumption were investigated. The authors showed that neuron activity was accompagnied by a decrease in tissue oxygenation and that this oxygenation can be used to predict "the orientation selectivity and ocular dominance of neighboring neurons" (Thompson et al. 2005, full reference below).

Reference:
Thompson, J.K., Peterson, M.R., and Freeman, R.D. 2003. Single-neuron activity and tissue oxygenation in the cerebral cortex. Science 299(5609):1070-1072



Composite picture showing an APOX microsensor inside brain tissue.
Courtesy Dr. Jeff Thompson