BioLogic

# Applications of scanning probe electrochemistry– Sensors

## SCAN-Lab

September 2021

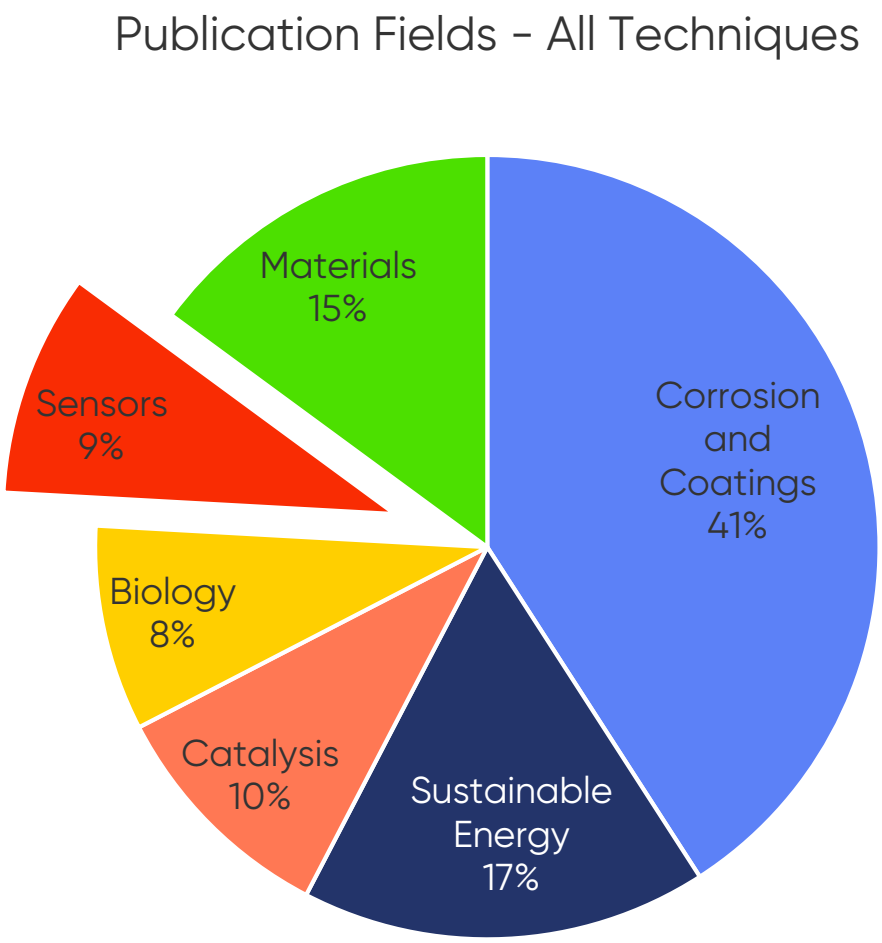
Version 1.0

# Background

# Background

**9% of commercial scanning probe electrochemistry instruments are used in sensors research.**

**This document will further investigate the role of scanning probe electrochemistry in the field of sensors.**

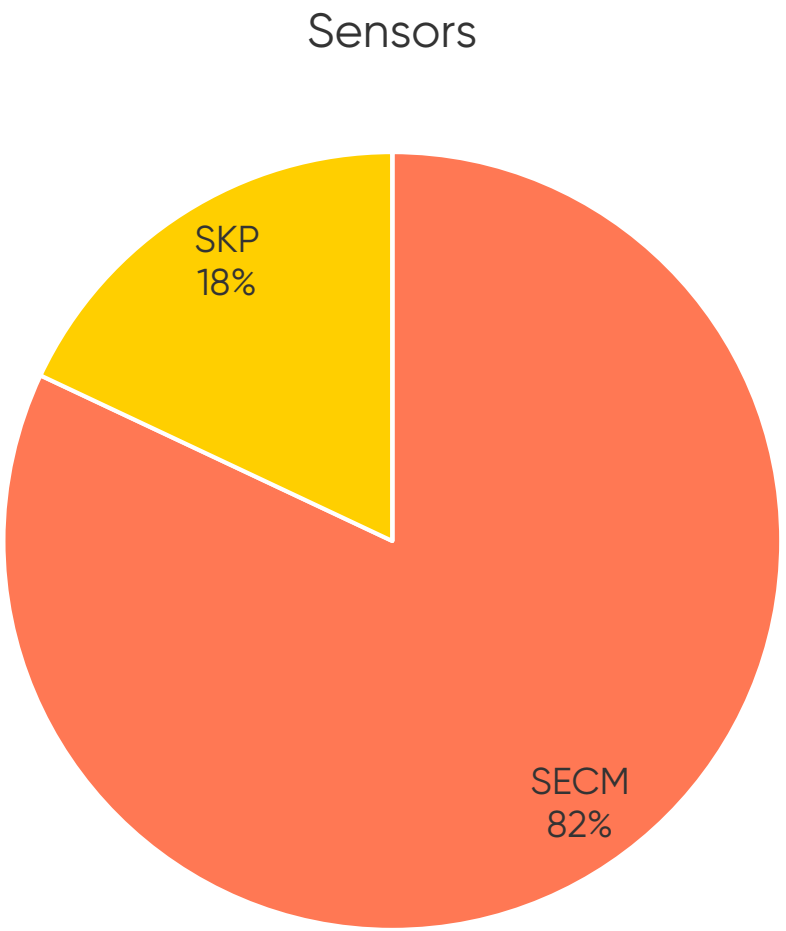


# Why is scanning probe electrochemistry applied in sensors?

**Scanning probe electrochemistry is used in fundamental R&D studies of sensors to:**

- Investigate the sensor analyte interaction
- Research novel sensor materials and structures
- Perform electrode modification
- Analyze ion selective membranes

# What techniques are used?

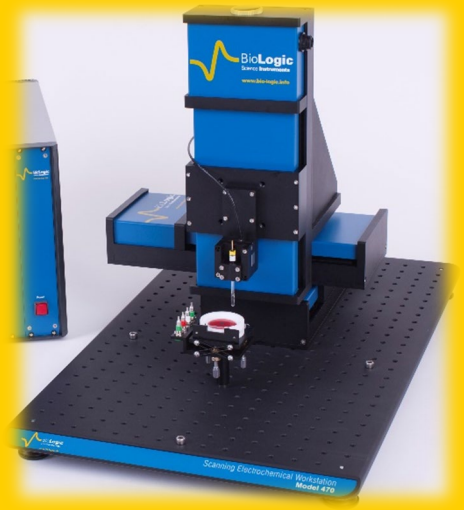



**Though there has been some application of SKP to sensor studies, SECM is by far the most popular scanning probe electrochemistry technique to be applied in this field.**

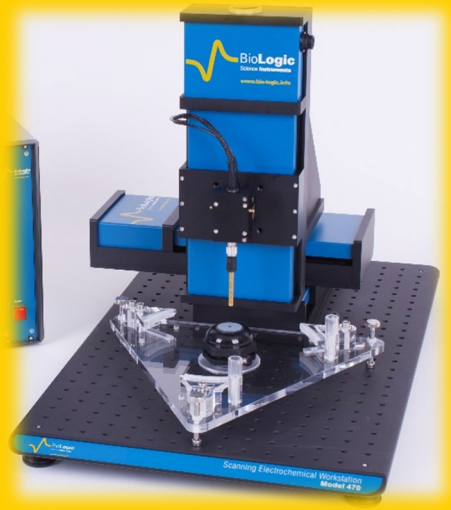
Source: Analysis of scientific publications citing commercial instruments. Each research group was only counted once per technique.

# What techniques to use for sensors?

SECM




SKP



# Sensors

# What are the research problems?

**Bulk techniques are an average measure of the sensor system, and therefore do not provide insight on the local properties of the sensor, e.g. activity of the regions.**

- Solution: Local measure of electrochemical activity

**It is important to understand the effect and repeatability of electrode modification.**

- Solution: Direct comparison of bare and modified electrodes

**Traditional techniques to investigate biosensors require sample pre-treatment, including fluorescent labelling limiting their applicability.**

- Solution: Measurement without pre-treatment

**Understanding sensor systems requires knowledge of the reactants, products, and ions involved in the system.**

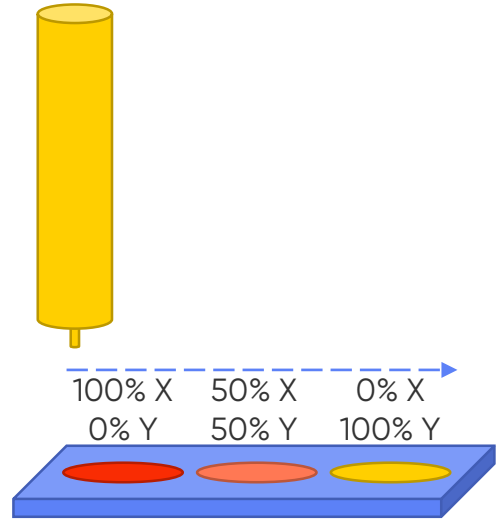
- Solution: Chemical selectivity

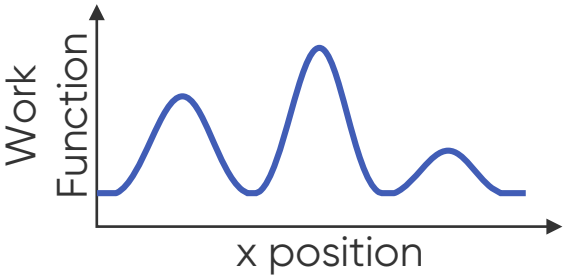
# Solution: Local measure of electrochemical activity

## How this is met by scanning probe electrochemistry:

When sensor investigations are performed using bulk techniques the result is an average of the bulk sample. This can be difficult or impossible to interpret to determine the effect of local structure on activity towards an analyte.

In scanning probe electrochemistry only the area under the probe is measured, providing local data. The electrochemical characteristics measured by scanning probe electrochemistry relate to a sample's activity. By raster scanning the probe across the sample an x-y map of activity can be produced.

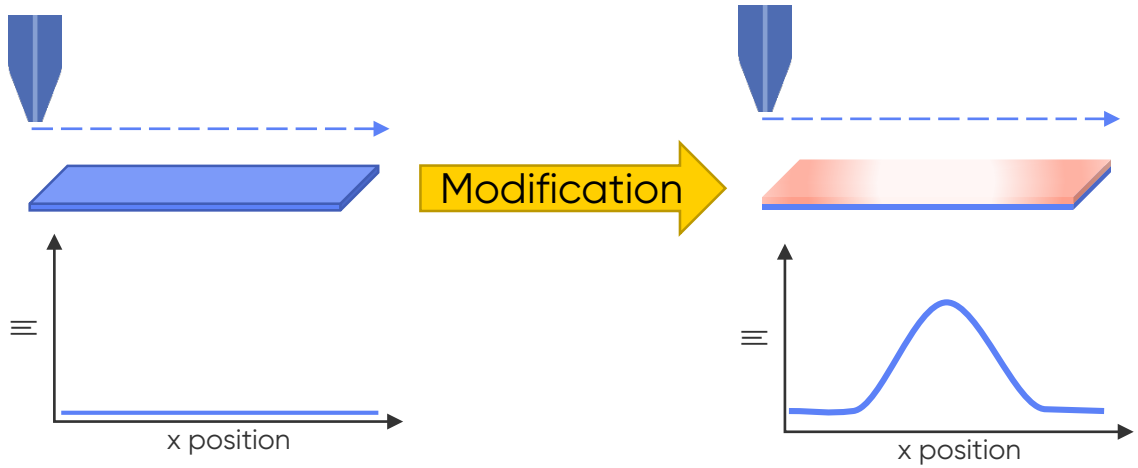


# Solution: Direct comparison of bare and modified electrodes

## How this is met by scanning probe electrochemistry:

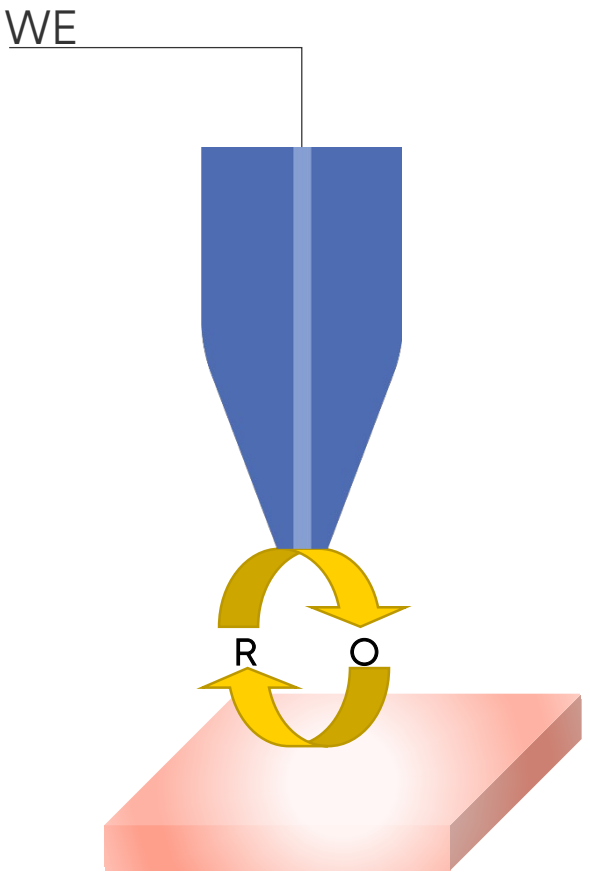
Modification of sensor electrodes alters the electrochemical characteristics of the electrode. Using scanning probe electrochemistry the electrochemical activity of the sample can be quantitatively mapped before and after modification. These maps can be directly compared to see the local effects of modification on the sensor sample.



# Solution: Measurement without pre-treatment

## How this is met by scanning probe electrochemistry:

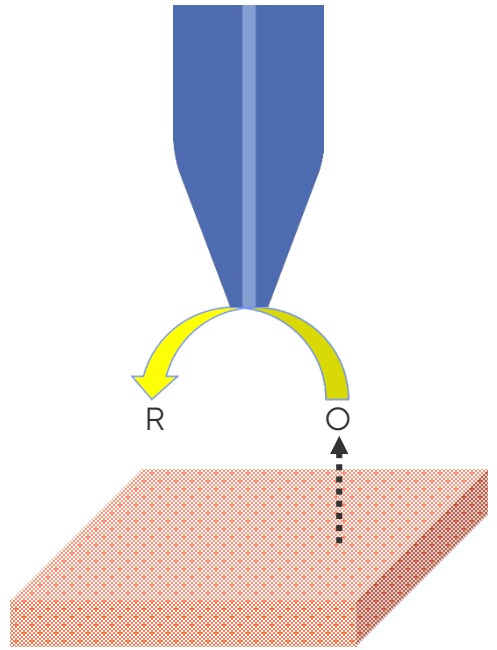
Many microscopies require the use of tags, or other pre-treatments which affect the system under study, and increase the required setup time. Scanning probe electrochemistry uses characteristics inherent to the sample to perform the measurement. SECM has the further advantage that it does not require electrical contact to the sample. All of this means that in scanning probe electrochemistry the sample is measured as is, without a lengthy preparation.



# Solution: Chemical selectivity

## How this is met by scanning probe electrochemistry:

Chemical selectivity is specifically met by SECM.
In SECM the probe is biased to interact selectively with a given electrochemically active species. SECM can be used to perform quantitative measurements with chemical selectivity, with changes in current signal directly reflecting the concentration of the species of interest.



# Conclusions

# Summary

- Scanning probe electrochemistry is used to measure the local electrochemical activity of a sensor sample.
- Scanning probe electrochemistry offers a method of directly comparing the bare and modified electrodes.
- Scanning probe electrochemistry allows measurement without pre-treatment.
- Measurements with chemical selectivity are possible using scanning probe electrochemistry.
- In sensor research SECM is of the most interest, with SKP also used.

# Why SCAN-Lab?

**Using BioLogic's scanning probe electrochemistry instruments it is possible to locally measure sensor systems without the need for pre-treatment. BioLogic offers a wide range of techniques applicable to sensor research on a single, flexible, user-friendly platform. This expands the current and future research avenues available from a single instrument.**

# Learning Center Article

A series of Learning Center articles has been created to help determine the most appropriate technique for a given research problem. This includes an article dedicated to sensors research:

## Scanning Probes & Sensor Research

# Acronyms

- SECM: Scanning ElectroChemical Microscopy
- SKP: Scanning Kelvin Probe