UPPSALA UNIVERSITET

# Study of Copper Corrosion in Pure Water

Co-workers:
Prof. R. Berger
Prof. M. Boman
Prof. T. Gustavsson
Prof. L. Nyholm
Prof. G. Westin
Dr. M. Ottosson
Dr. C. Olsson
Dr. M. Klintenberg
Dr. I. L. Soroka

***Prof. Yvonne Andersson***
**Department of Materials Chemistry**
**Uppsala University**

**SKB:s referensgrupp möte för kopparkorrosion i syrefri miljö.**
**Möte 3,Stockholm, Sweden, 27 augusti 2010**

UPPSALA UNIVERSITET

# The Ångström Laboratory

## Materials Chemistry

Other Departments at the Ångström Laboratory:
Technology, Physics, Physical Chemistry,
Photochemistry & Molecular Science, Mathematics,

UPPSALA UNIVERSITET

## Materials Chemistry

**Syntheses of new compounds and materials**

Thin films

Nano-sized particles

Bulk

**Characterization**

X-ray diffraction

electron microscopy

Electrochemical methods

ESCA

Raman spectroscopy

UPPSALA UNIVERSITET

## Experimental

Sample preparation: Cu 99.95% purity

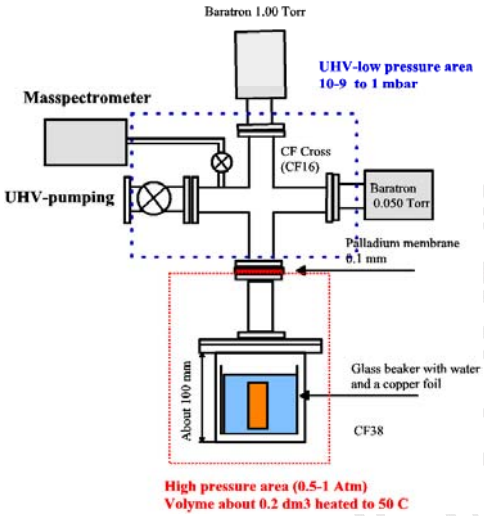
1. Mechanically polished
2. Electrochemically polished

Experimental set-ups:

1. Milli-Q water
2. Cu in water
3. Cu in diluted acid
4. Cu in $H_2O^{18}$

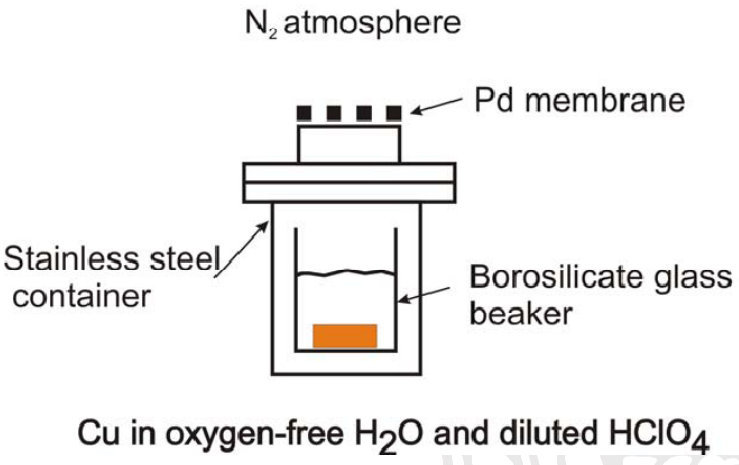
UPPSALA UNIVERSITET

Vacuum system for measurements of hydrogen production during copper corrosion.




UPPSALA UNIVERSITET

# Parallel experimental arrangements




Cu in oxygen-free $H_2O$ and diluted $HClO_4$

UPPSALA UNIVERSITET

## Experimental methods to study Cu corrosion products

- The thickness of the surface layer as well as its composition can be studied by **XPS (ESCA)** analysis.
- **ICP-MS** to measure trace amounts of elements in the water. The detection limit for Cu in solution is $2\times10^{-11}$ g/mL.
- **GD-OES** (Glow discharge optical emission spectrometry) to study hydrogen concentration gradients in Cu.
- **FTIR** (Fourier Transform Infrared Spectroscopy) and **SERS** (Surface Enhanced Raman spectroscopy) to detect the O-H, Cu(I)-O, Cu(II)-O etc. vibrations.
- **GI-XRD** (X-ray diffraction and grazing incidence X-ray studies)
- **pH** of the water solution will be controlled after immersing the Cu foil into the water
- Soft X-ray analysis (**XAS** and **XES**).

UPPSALA UNIVERSITET

## Factors, which may influence the detection limit of $H_2$

- UHV system leaks (external and interior)
- Outgassing rate of UHV components (chambers, glue)
- Palladium membrane
- Cu metal surface can catalyze hydrogen development

UPPSALA UNIVERSITET

Vacuum system for measurements of hydrogen production during Copper corrosion.