Aalto University
School of Chemical
Engineering

The effect of oxide layer on copper corrosion in repository conditions (OXCOR)

Jari Aromaa
Aalto University
Hydrometallurgy and Corrosion Research Group

OXCOR research tasks

- **Before emplacement of the canister in the disposal hole the copper surface will have an oxide film.**
- **The research question:**
  - Can the oxide film increase copper corrosion rate in groundwater or porewater?
- **The research tasks:**
  - Produce oxide films on the surface of clean copper simulating the oxidation in air when canister surface is hot.
  - Characterize the oxide film composition and thickness
  - Measure the effect of oxide film on corrosion rate in different groundwater and porewater environments.

OXCOR experiments

- **Oxygen free copper, non-oxidized or 7 days in air at 100 ºC.**
- **Long-term corrosion tests**
  - Immersion tests at room temperature, 8 or 40 months total time.
- **Short-term corrosion tests at elevated temperatures**
  - Electrochemical monitoring, 3-4 weeks
- **Synthetic waters under air or nitrogen purging**

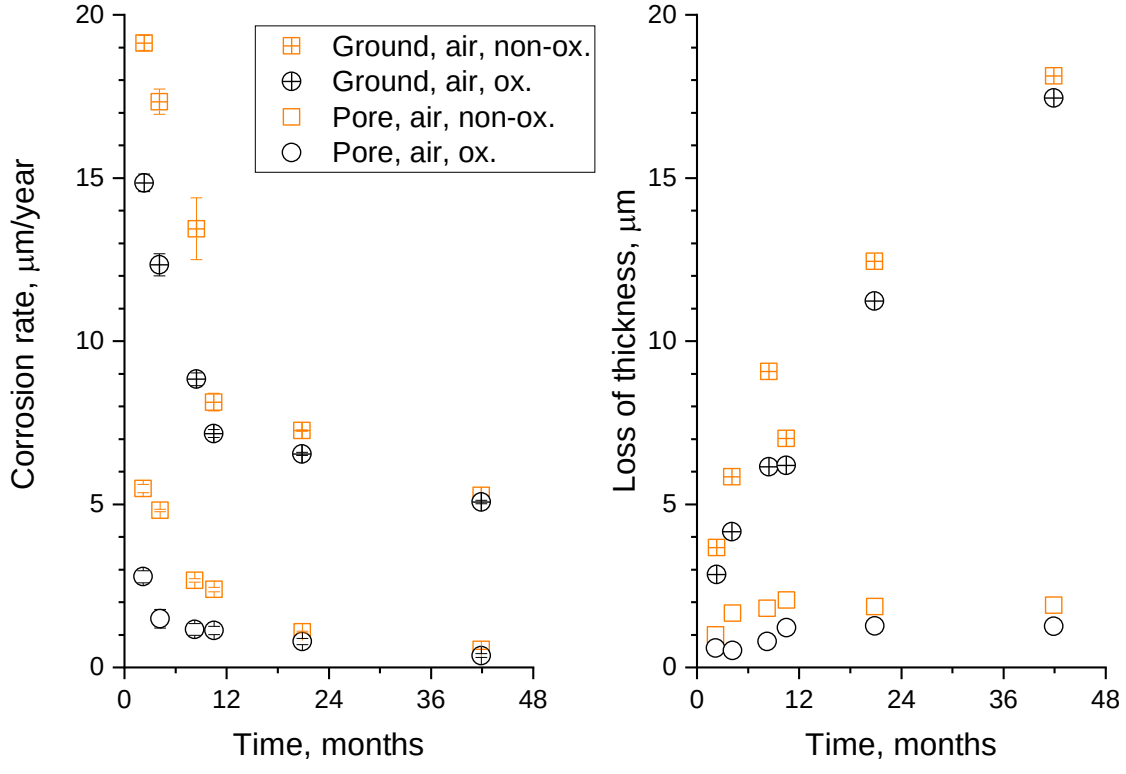
	Ground water	Pore water
pH	8	10
Cl^-, mg/l	5340	80
SO_4^{2-}, mg/l	580	1300
TDS, mg/l	10070	3360

OXCOR oxide film results

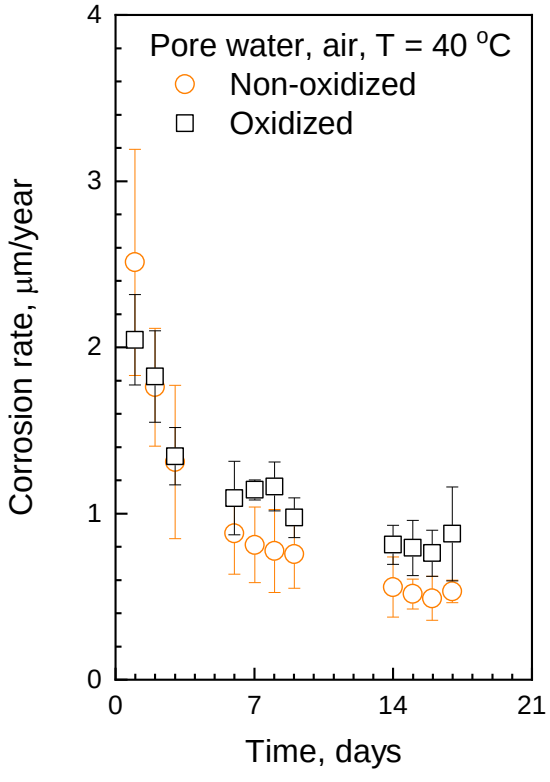
- **Oxidation in dry air, T = 100 ºC, ellipsometry and SEM.**
- **Oxide growth starts as small islands**
- **The oxide film is mostly Cu_2O, and CuO develops only after several days at 90–100 ºC.**

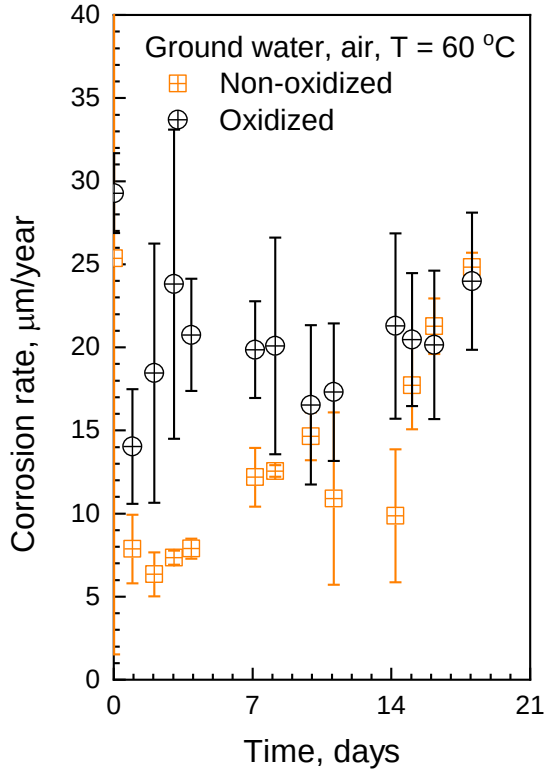
17 days	35 days	56 days	77 days	101 days
46 nm	47 nm	78 nm	127 nm	130 nm

OXCOR long-term tests



OXCOR short-term tests

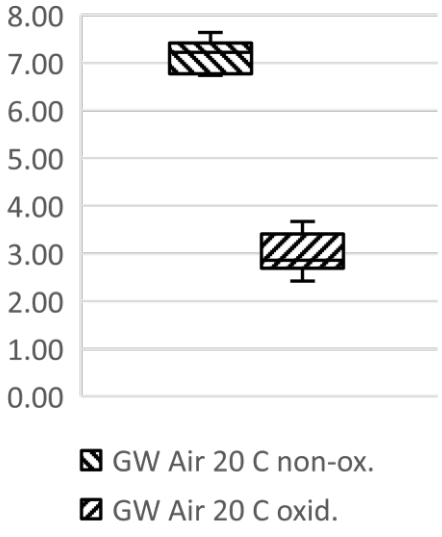


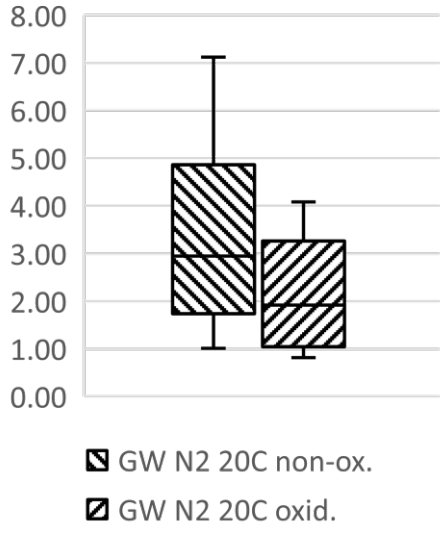


OXCOR comparison method

- **Box-and-whisker plot**
- **t-test, two samples with unequal variances**

- **Do the plots overlap**
- **Are the mean values different**





OXCOR summary

The oxide film had usually no effect on corrosion. In the cases where effect was seen, corrosion rate increased by factor of two or decreased to half.

Water	Purging	T = 20 ºC	T = 40 ºC	T = 60 ºC	T = 80 ºC
Ground	Air	Decreases	No effect	Increases	No effect
Ground	Nitrogen	No effect	No effect	No effect	No effect
Pore	Air	Decreases	No effect	No effect	No effect
Pore	Nitrogen	Increases	No effect	No effect	No effect