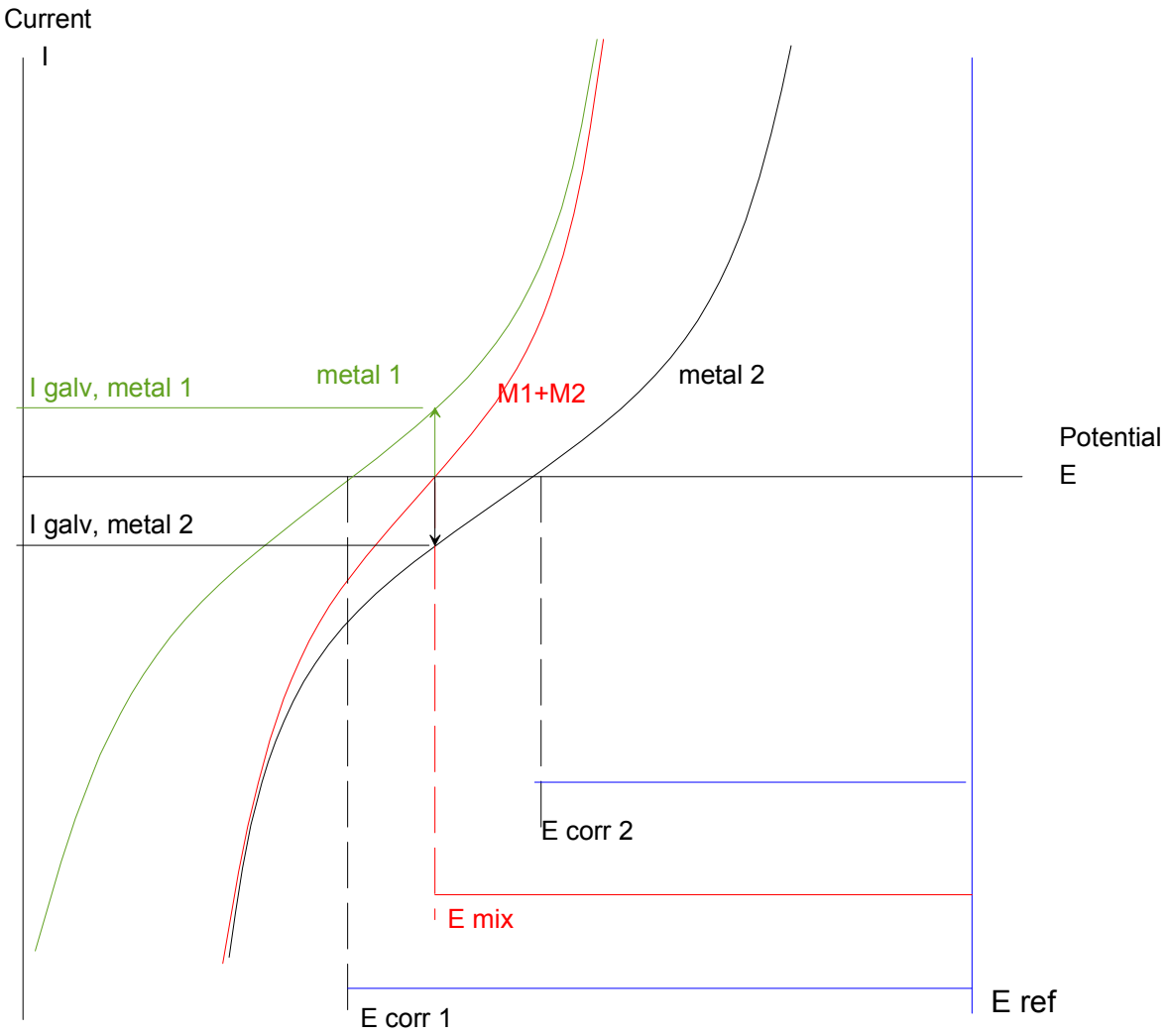
Galvanic Corrosion Research

Theoretical Aspects

Imagine you measured in one experiment the green polarisation curve below, showing active dissolution of metal 1. In another experiment using a different metal in the same environment you got the black polarisation curve.



For both metals you could calculate the corrosion current densities I corr1 and I corr2 from the semi-log Tafel plots. If you connect both metals to one another, you would get a polarisation curve like the red one plotted above. You could calculate the corrosion current density for this pair of electrodes, which is shown as "I galv" here.

Besides small displacements I galv will be the current which is found when you measure the polarisation curve of the coupled electrodes. However: I galv is NOT the total corrosion current of metal 1, but the contribution of the galvanic coupling to the corrosion current of metal 1 as a single electrode: The corrosion current of metal 1 coupled to metal 2 is (approximately) the sum Icorr, metal1 + I galv.

Accordingly, the corrosion current of metal 2 decreases by:

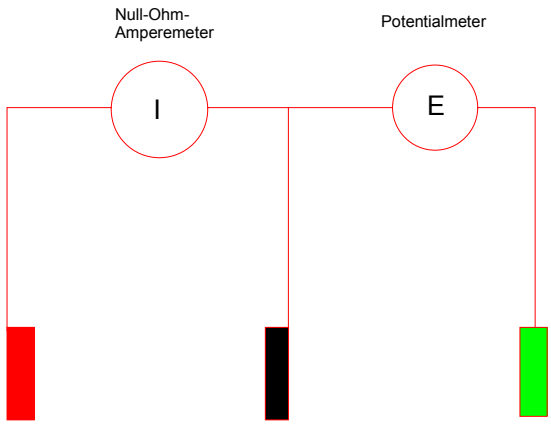
I = I corr 2 – I galv, metal 2

(while I galv, metal2 = -I galv, metal 1)

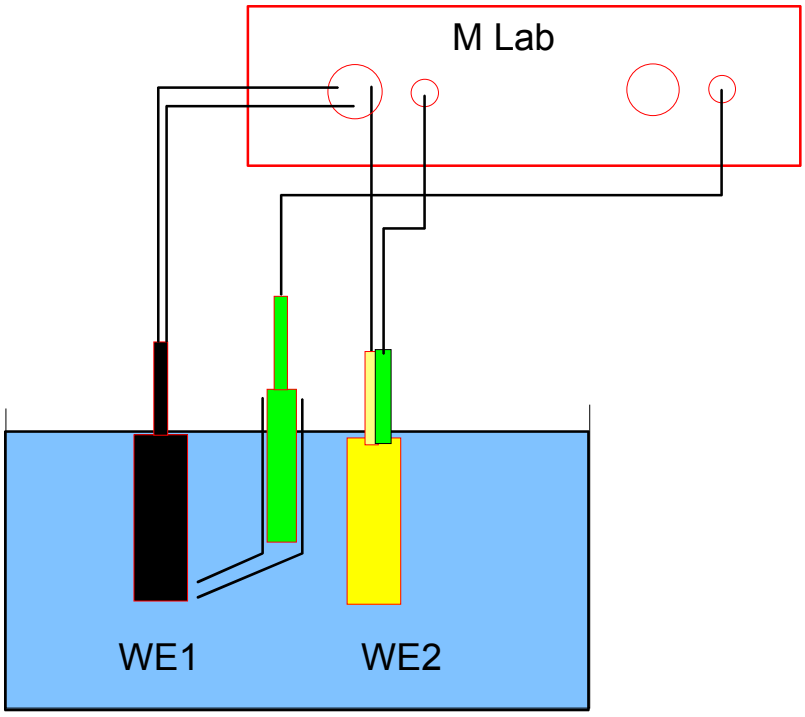
Since the corrosion potentials E corr1 and E corr2 are different, the corrosion potential of the galvanic coupling is a mixed potential between E corr1 and E corr2.

Practical measurement using MLab:

Use channel 1 of the MLab to measure the short circuit current using the ZRA- set-up given in section "Short Circuit Measurement", and use the reference electrode input of channel 2 to measure the potential of metal 1 coupled to metal 2 via the ZRA. The potentials of both metals are identical now; therefore the Haber-Luggin-capillary may be placed to either of the electrodes.

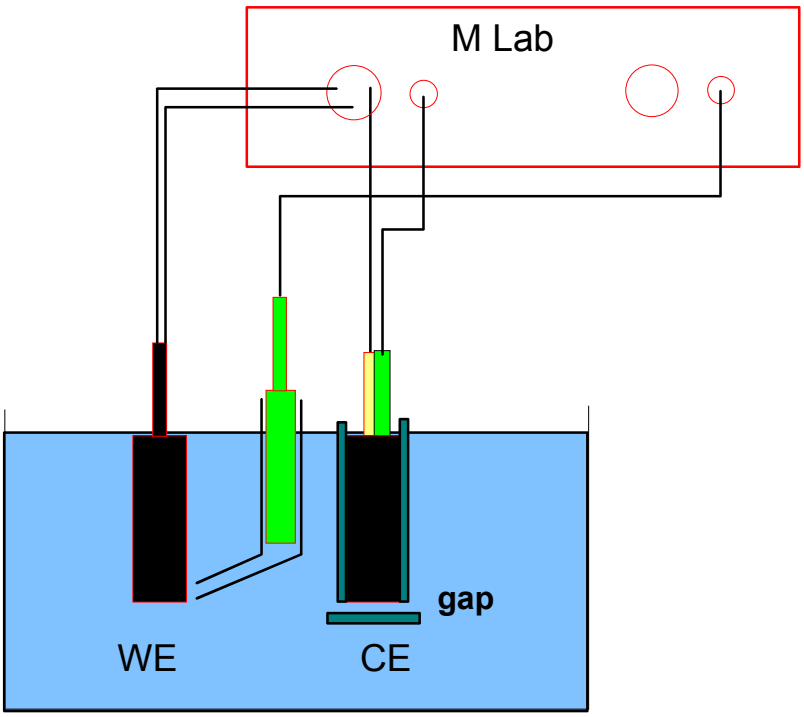


Schematic set-up



Connecting the MLab for measuring galvanic couplings: WE2 is then the second metal, connected to the counter electrode terminal. When the potential is controlled to 0, the current passing between WE and CE is the galvanic current Igalv.

As a special case, metals 1 and 2 may be identical, but the local environment is different. This is the case when you consider passive metals, and one of the electrodes is situated in a narrow gap. The oxygen concentration there will decrease, and it may start to corrode actively: crevice corrosion happens.



Crevice corrosion research: electrodes made of identical materials are used. One of them is open to the bulk solution; the other one is situated in a narrow gap.