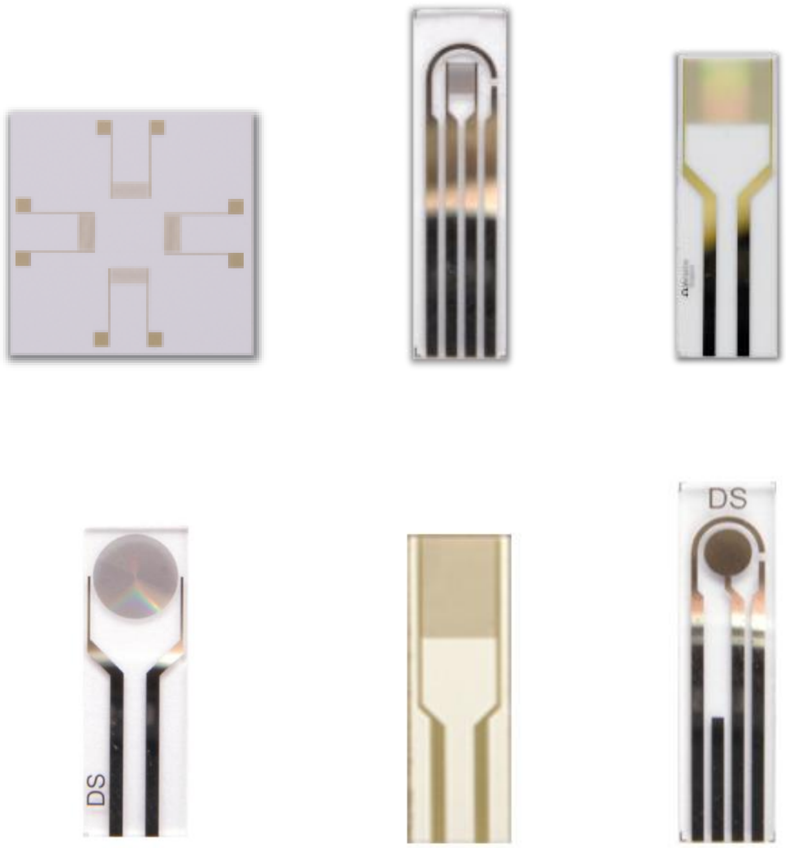

DS APPLICATION AREA: FUNDAMENTALS

K_{cell} determination through impedance measurements

Summary

Conductivity of a solution (κ) can be related with a constant parameter of the sensor, defined as cell constant (K_{cell}), according to the equation:

$$\kappa = \frac{K_{cell}}{R}$$

Where R is the resistance measured.

In general, the higher the conductivity of the solution, the greater the K_{cell} required.

The cell constant value is related to electrode geometrical parameters (such as digit length, number of digit pairs, gap between digits…). This constant can be determined experimentally[1]. The cell constant is defined as:

$$K_{cell} = \frac{R_{sol}}{\rho_{sol}}$$

Where R_{sol} is the resistance of the medium and ρ_{sol} is electrolyte resistivity.

The cell constant could be determined by immersing the electrode in a standard solution, generally potassium chloride, whose conductivity at different

temperatures and different concentrations is known. Impedance measurements allow to determine R_{sol} at frequencies where phase angle is 0 or close to 0 (Bode plots).

Apparatus and accessories:

Impedance measurements are carried out with an Autolab PGSTAT 204 controlled by NOVA 1.10 software. Impedance spectra were taken in the range from 100 Hz to 1x106 Hz, RMS 10mV (peak-to-peak amplitude). There is an equilibration time before each measurement of 5 s. Measurements were performed with IDEs, multi-interdigitated electrodes and SPEs of different geometry and materials.

K_{cell} is calculated as the slope from the plot Impedance (|Z|) vs Solution resistance (ρ).

Reagents:

KCl solutions are made from dilutions of a conductivity standard 1.0M (111,8 mS/cm). The conductivity from KCl solutions is calculated by Kohlrausch equation ($EC = \sum(c_i x f_i)$; c_i=mg/L and f_i is the conductivity factor).

Method:

The impedance spectra of each sensor immersed in the different KCl solutions were registered. All measurements were done at 25-26ºC. |Z| (or solution resistance) is plotted versus the inverse of the conductivity (or resistivity) at a frequency where ϕ or angle phase is close to 0 or has minimum value. The slope of these curves is the electrodes cell constant.

Results:

Electrode REF.	Frequency (KHz)	Conductivity range ($\mu S\ cm^{-1}$)	K_{cell} (cm^{-1})
G-IDEAU5	200	84 - 12880	0.006
G-IDEAG5	200	84 - 1413	0.006
G-IDEPT5	100	84 - 12880	0.006
G-IDECU5	500	84 - 12880	0.006
G-IDEAU10	200	84 - 12880	0.012
G-IDEPT10	200	84 - 12880	0.012
G-IDECONAU10	200	84 - 12880	0.013
G-IDECONPT10	200	84 - 1413	0.013
P-IDEAG50	200	84 - 12800	0.059
P-IDEITO50	200	84 - 1413	0.059
PW-IDEPD50	200	84 - 12800	0.059
PW-IDEAU50	32	84 - 12800	0.059
PW-IDEPD100	200	84 - 12800	0.124
P-IDEITO100	25	84 - 1413	0.124
P-IDEAG100	25	84 - 12800	0.124
PW-IDEAU100	100	84 - 12800	0.124
P-IDEAU100	100	84 - 12800	0.124
IDEAU200-HPT-WB	200	84 - 12800	0.220
IDEAU200	200	84 - 12800	0.220
G-IDE222	400	84 - 12800	0.107
G-IDE555	400	84 - 12800	0.107
PW-4XIDEAU20	200	84 - 12800	0.300
PW-4XIDEAU30	200	84 - 12800	0.467
PW-4XIDEAU40	200	84 - 12800	0.600
PW-4XIDEAU50	200	84 - 12800	0.700
PW-4XIDEAU60	200	84 - 12800	1.050
PW-4XIDEAU70	200	84 - 12800	1.050
TLFCL222AT	50119	84 - 12800	10
X1110	50119	84 - 12800	2.710

References:

[1] De la Rica, R.; Fernández-Sánchez, C.; Baldi, A. *Electrochem. Commun*. **2006**, *8*, 1239.