

### Characteristic and usage

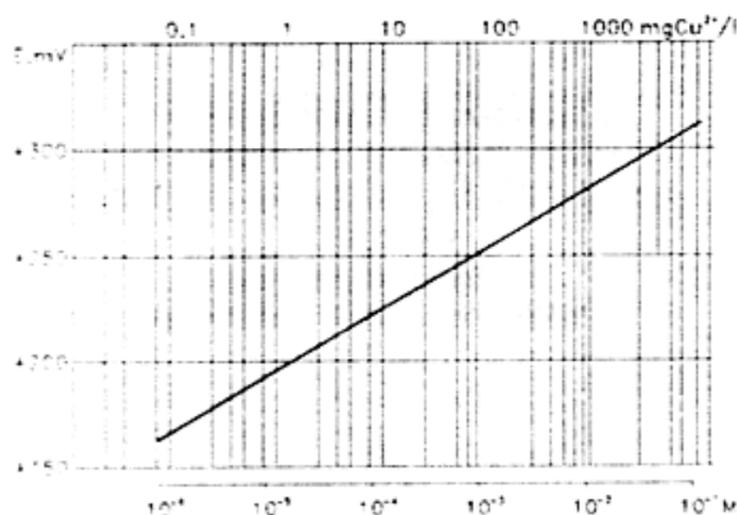
The polycrystalline copper electrode type ECu-01 is designed for direct measurements of activity or concentration of copper ( $\text{Cu}^{2+}$ ) ions in aqueous solutions and also in many water-organic mixtures. The measurements may be done in two ways, by direct measurement or using any of the techniques based on the growth (adding or subtracting) of Cu ion concentration in the sample.

This electrode may be specially useful in comprehensive potentiometric titration, used for indirect indicating cations of  $\text{Ca}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$  or  $\text{Ni}^{2+}$ . Used as a indicator of the end point of titration enables measuring concentration of the chosen cation and concentration of the substance which is reacting with this cation.

The typical applications of the Cu electrode are copper measurements in galvanic baths, metal etching baths, refining metal ores, soil samples, waste water, industrial water, food products, drinks etc.

### Electrode Reaction

Measuring the copper ions concentration is based on measuring the difference between the measuring and the reference electrodes, which immersed in the measured or sample solution create a measuring link. Changes in the  $\text{Cu}^{2+}$  ion concentration in the solution cause changes of the ECu electrode potential what is equal to changes of the electromotive force (EMF) measured by ion or pH meter. The dependence between the Cu electrode potential and the Cu ions concentration usually is



Graph 1. Characteristic of the Copper electrode type ECu-01 in relation with (AgAgCl) reference electrode type RL-100, in solution  $\text{CuSO}_4$  with addition of 0.1 M  $\text{NaNO}_3$ .

showed in graphical form called a electrode characteristic curve. Typical characteristic of the Cu electrode, determined on  $\text{CuSO}_4$  sample solution in relation with RL-100 reference electrode is showed on the graph 1.

To make the changes of the electrode potential proceed according to Nernst's law, it is necessary to stabilise on the equal level the ion strength and the pH level in the sample and measured solutions, it is done by introducing equal portions of electrolyte which is not interfering the electrode work. One may use saturated  $\text{NaNO}_3$  solution. Because the  $\text{Cu}^{2+}$  ions are capable to create a durable complexes it is necessary to ensure that they will have very close complexity level both in the sample and in the solution.

### Interference

The copper electrode is reacting selectively in presence of many cations. Important interference may be created by ions which are able to create a difficult to dissolve precipitates, this are  $\text{Ag}^+$   $\text{Hg}^+$  and in some way also the  $\text{Pb}^{2+}$ . The source of the interference may also be the conditions which reduce  $\text{Cu}^{2+}$  ions and  $\text{Cl}^-$   $\text{Br}^-$  or  $\text{Fe}^{3+}$  which if appear in high concentration may cause changes in the composition of the surface layer of the membrane.

Cations  $\text{Ag}^+$  and  $\text{Hg}^{2+}$  before the measurement should be removed from the measured solution. It is done by precipitation or complexing. This same situation is with  $\text{Pb}^{2+}$ , if their concentration isn't greater than 1/10 of the  $\text{Cu}^{2+}$  ions concentration. The reducing substances have to be tentatively oxidised (ex. using  $\text{HNO}_3$  or  $\text{H}_2\text{O}_2$ ).

The interference caused by bromide and chloride ions may be eliminated by suitable diluting of the measured sample. The influence of the  $\text{Fe}^{3+}$  may be eliminated by increasing the pH of the sample above 4 pH what will cause it's precipitation in hydroxide form, or by complexing them with sodium fluoride solution.

### Reference electrode

When choosing the reference electrode it is necessary to take into consideration the conditions and methodology of carrying the measurements. For measurements in laboratory it is advised to use the RL-100 electrode (AgCl) or RL-200 (calomel) equipped with electrolytic bridge. In case of measurements in industrial conditions (ex. in continuous measurements or in samples under increased pressure), it is advised to use reference electrodes RP-100 or RP-200. It is also possible to use reference electrode without the electrolytic bridge (ex. RP-10) placing them in the sample stream behind the Copper electrode.

### Methodology of making the measurements

The described below methodology concerns the measurements in laboratory conditions in range 0,1 to 1000 mg  $\text{Cu}^{2+}$ /l.

### General notices

- Before starting the measurements it is necessary to bring the temperature of sample and measured solutions to the surrounding (ex room temperature).
- The sample and measured solutions should have similar pH value and ionic strength.
- Solutions with high Cu ions concentration, exceeding 1000 mg  $\text{Cu}^{2+}$ /l (0,016mol/l) before the measurement should be diluted.
- Between the measurements the electrodes should be carefully washed in distilled water, it is very important not to bring the contaminants from one sample to another.
- Before the measurements it is necessary to remove the strongly interfering ions.

### Preparing the electrode for the measurements

Few hours before starting the measurements, it is advised to immerse the electrode in the  $\text{CuSO}_4$  or  $\text{Cu}(\text{NO}_3)_2$  with concentration about 0,1 g  $\text{Cu}^{2+}$ /l. This behaviour enables better reaction time and improves electrode potential.

The reference electrodes RL-100 and RL-200 are delivered with the outer chamber filled with saturated KCl solution. When starting work with new RL100 or RL-200 electrode it is necessary to take off a protective ring from it's end, holding the socket unscrew the outer

chamber, pour out the electrolyte (KCl), wash it with deionized water. Fill in the chamber with protective electrolyte, leaving an air bubble (about 1 cm<sup>3</sup>). As a protective solution a 1M KNO<sub>3</sub>, NaNO<sub>3</sub> or saturated K<sub>2</sub>SO<sub>4</sub>. After filling screw in the chamber into the socket.

#### Measuring link

- prepare few solutions which differ one from another in the concentration 10 times. It is done by diluting with deionized water the concentrated sample solution. To receive a solution with 1000 mg Cu<sup>2+</sup>/l it is necessary to solve in water 3,929g CuSO<sub>4</sub> · 5H<sub>2</sub>O, and next fill it with water to 1000ml. Next to each 100 ml of the sample solution add 2 ml of ion strength stabilising solution, it should include in 1000 ml 425 g NaNO<sub>3</sub> and next stir it accurately.
- Connect the copper and reference electrodes to the meter prepared for mV measurement.
- Wash the electrodes with deionized water and next immerse them in the sample solutions (stirred) starting with the one with lowest concentration. After placing the electrode in each of the solutions read and write down the value. Remember about the order of immersing in solutions and washing the electrodes between each measurement.
- According to gathered data prepare the curve placing on the vertical axis the measured values and on the horizontal one the values of the sample solutions.

#### Using the concentration curve

- prepare the measured solution by adding to it the ion strength stabilising solution. add this same volume of the solution 2 ml / 100 ml of the solution.
- Connect the electrodes with the meter and prepare it for mV measurement.
- Wash the electrodes with deionized water and place them in the measured solution.
- After stabilisation read and write down the value.
- Using the earlier prepared curve read the value of Cu<sup>2+</sup> ion concentration in the measured sample, which responds to the measured mV (Electromotive Force)

#### Maintenance of the electrode

The copper electrode Ecu-01 practically does not require any maintenance, beside protecting the membrane surface against contaminating. Strongly contaminated electrode should be washed in water with detergent (ex. washing up liquid) or with right organic solvent. Membrane contaminated with interfering ions may be regenerated by polishing it with very fine sand paper (600) and next polished with paste made of aluminium oxide placed on felt.

#### Storing the electrode

During short breaks between the measurement (ex. night) the electrode may be stored in CuSO<sub>4</sub> solution with 0,1 g Cu<sup>2+</sup>/l concentration. The electrode shouldn't be stored in the deionized water. During longer breaks between the measurements the electrode should be stored dry ex. in the box delivered by the manufacturer. During short breaks in measurements the reference electrodes RL-100 and RL-200 should be rather stored unscrewed, placing the inner link in KCl solution and the outer chamber in the protective electrolyte. In case of longer breaks between measurements the outer chamber should be filled with KCl solution and screwed together and the junction should be protected with the rubber ring and place it in the box.

#### Technical Data

Measuring Range	10 <sup>-6</sup> ÷ 1 mol Cu <sup>2+</sup> /l (pCu <sup>2+</sup> ) 0.06 ÷ 63.500mg Cu <sup>2+</sup> /l (ppmCu <sup>2+</sup> )
Sensitivity	27 ± 2 mV/pCu <sup>2+</sup>
pH range	3 ÷ 6 (direct measurement) 2 ÷ 13 (titration)
Temperature range	0 ÷ 80°C (short period work) 0 ÷ 40°C (continuous work)
Membrane resistance	10 ÷ 50 kΩ (25°C)
Reaction time	30 ÷ 60 s
Selectivity Coefficient	Ca <sup>2+</sup> = 4 × 10 <sup>-5</sup> Cd <sup>2+</sup> = 10 <sup>-4</sup> Pb <sup>2+</sup> = 8 × 10 <sup>-3</sup>
Durability	12 months of work in standard laboratory conditions
Dimensions	
- Diameter	12 mm
- Length	120 mm
Cable length	approx. 1 m
Connector	BNC-50

**ELMETRON**

41-814 ZABRZE ul. W. Witosa 10  
tel. +48 32 273 81 06, fax +48 32 273 81 14  
POLAND

[www.elmetron.com.pl](http://www.elmetron.com.pl)  
e-mail: [info@elmetron.com.pl](mailto:info@elmetron.com.pl)