Equipment for measuring potentials

1. The setup

The following schematic drawing shows the equipment needed for automatic data collection.

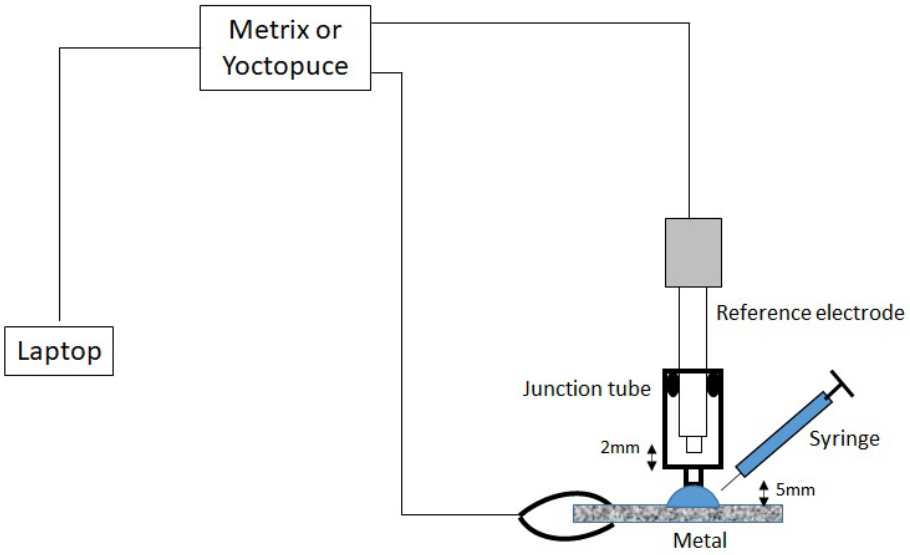


Fig. 1: Setup showing the equipment needed for automatic measurement of potentials.

2. The measuring system

The measuring system consists of a reference electrode (RE) and a junction tube. Measurements are made with respect to the Ag/AgCl electrode (210mV/standard hydrogen electrode - SHE: 0V). As the RE is equipped with a frit at its tip which allows exchanges between the solution contained in the RE and the external environment, the electrode is inserted in an junction tube which is itself equipped with a frit at its tip (see picture below) in order to avoid any pollution of the external environment. A Teflon tape applied to the RE keeps the junction tube in place (Fig. 2).

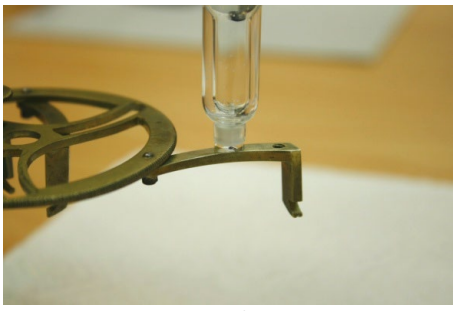
Fig. 2: The measuring system RE / junction tube.

The solution inserted in the junction tube is the same as the solution applied between the frit of the junction tube and the metal surface. The junction tube should be filled as much as possible to dilute any salt from the RE that diffuses through its frit. The junction tube is filled 20min. before the start of the measurements to ensure that the system is stabilised and the tip of the RE should be approximately 2mm from the frit of the junction tube. During the 20min., the RE/junction tube is held in a test tube filled with the solution used for the measurements (Evian water, KNO_3 or NaSesq.)

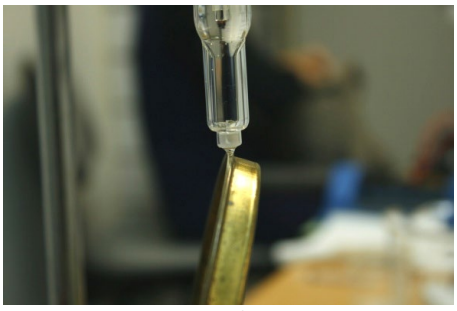
After polishing the surface of the metal material under study (SiC 4000), the RE / junction tube is positioned at a distance of 5mm from the polished metal surface. A constant volume of solution (20µL) is then applied between the frit of the junction tube and the metal surface with a syringe (rinsed with the test solution) (Fig. 3).

Fig. 3: Use of a syringe to insert a constant volume of solution between the RE/junction tube and the metal surface.

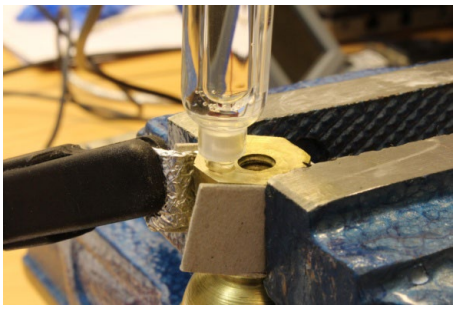
The distance between the tip of the junction tube and the metal surface should be such that the drop of solution is neither crushed (Fig. 4a) nor overstretched (Fig. 4b). Figure 4c shows the desired positioning. Sometimes the stretching of the drop or its crushing is due to the need to work on an extremely limited surface or the nature of the material (wetting metal).



a/



b/



c/

Fig. 4: Appearance of the drop of solution placed between the tip of the junction tube and the surface of the metal under study. Large drop on wetting surface (a/), stretched drop on a very limited surface (b/) and drop of desired size (c/).

Note that the proper functioning of the RE is essential. To do this, its potential is compared with that of another new RE in a conductive solution (the difference read on a voltmeter must correspond to that given by the difference in potentials supplied by the supplier).

- Ag/AgCl reference electrodes suppliers: Metrohm (https://www.metrohm.com/fr_fr/products/6/0733/60733100.html), Radiometer.
- Junction tube supplier : Radiometer (https://www.hach.com/p-radiometer-analytical-al100-replacement-salt-bridge-double-liquid-junction-length-70-mm-ceramic-junction/B40A520).

3. The voltmeter

For automatic data collection, the Chauvin-Arnoux Metrix range (www.metrix.fr) was initially selected because of the high impedance of the multimeter and the existing documentation for deciphering the bits (binary data) passed over the Port-Com (Fig. 5).

Fig. 5: M3282 model of Metrix range.

The multimeter is connected to the laptop via a USB cable. Furthermore, the COM output of the multimeter is connected to the RE / junction tube et V output to the metal). The Metrix M3282 multimeter has been interfaced in such a way that it can communicate with the "DiscoveryMat" application. Due to the change of model by the supplier and the need to

rewrite the code to allow the new model to communicate with the "DiscoveryMat" application, we opted for a new type of device which does not present the same problems.

The Yoctopuce (https://www.yoctopuce.com/) voltmeter is a plug and play system. It does not require any configuration, nor any driver to install. Just plug it in. It does not even have an on/off button. The red cable (with the brown banana plug) is connected to the metal while the black cable (with the white banana plug) is connected to the system RE / junction tube. It starts automatically, without any screen and menu where you have to configure anything. Furthermore, it is:

- Inexpensive
- Small
- Portable
- Very easy to use
- Hotplug ready

It has been tested and it gives the same results as the Metrix M3282.

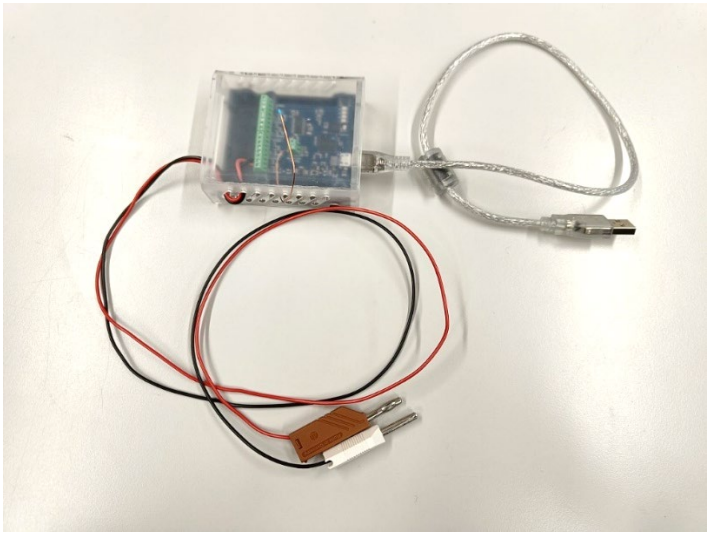


Fig. 6: Yoctopuce voltmeter assembled.

4. The other components

a. Electrode holder model Seven of Mettler-Toledo.

Fig. 7: Electrode holder Mettler-Toledo.

b. Stands + clamps and bosses

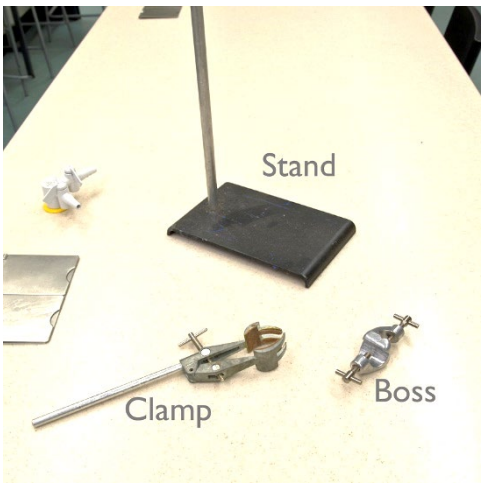


Fig. 8 : Stand, clamp & boss.

c. Cables and crocodile clamps
d. Syringes of 0.3mL with 5µL graduations.