



- Light and Portable Convenience
- Fast and Accurate Direct Measurement
- Long Life
- New Electrochemical Sensor(Park-Rapp probe)
- Printer Interface and Memory Storage



DIRECT MEASUREMENT OF DISSOLVED HYDROGEN IN ALUMINUM ALLOYS



### What is AlproH Palm?

*AlproH Palm* is a portable quick-measuring system for the determination of dissolved hydrogen content in molten aluminum alloys.

The system comprises of a **Probe**, an **Analyzer** (includes connecting line), and an optional **Probe stand**. The probe can use indefinitely until it breaks a part.

A patented PARK-RAPP probe, housed at the tip of the probe, provides an EMF output which depends purely on the hydrogen partial pressure ( $p_{H_2}$ ) and temperature in the melt. The sensor is housed in a robust, impact-resistant probe constructed from special high temperature alloy and graphite, which ensures that the *AlproH Palm* is able to withstand the harsh environments in the Al foundry.

The sensor and temperature outputs are fed into the analyzer, which when combined with the alloy interaction parameters, gives the dissolved hydrogen concentration in units of **ml/100g Al**.

### How it works ...

The technology is based on a novel **solid electrochemical hydrogen sensor**, so called *Park-Rapp probe*, which, at an elevated temperature, is able to measure hydrogen content with reference to oxygen in the air through the adoption of proton conductor/oxygen ion conductor hetero-junction electrolytes. The principle behind how it can be used to measure hydrogen concentration is described below:

An impervious section of *Park-Rapp probe* (yellow and grey tube) is coated with Pt electrodes on both faces. The inside of the sensor (reference electrode) is exposed to the oxygen-containing air and the other side (working electrode) is to the hydrogen gas in the melt. For this arrangement, the measured EMF of the sensor,  $E$  is expressed as

$$E = E^0 + 9.921 \times 10^{-5} T \log[H_2]$$

, i.e. it depends logarithmically on the hydrogen partial pressure at the working electrode immersed in the melt. Here  $E^0$ , and  $T$  are sensor constant, and absolute temperature, respectively.

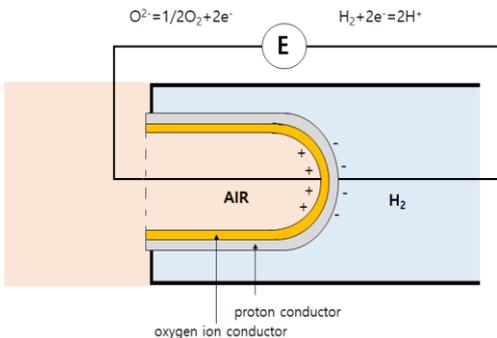
The schematic diagram below shows how a voltage is generated across the solid hetero-junction electrolyte exposed to a given hydrogen partial pressure ( $p_{H_2}$ )

Thus the hydrogen concentration can be calculated from the measured EMF. To work out the dissolved hydrogen content in the melt, the solubility of hydrogen for Al melt must be known. From Sievert's law, the dissolved hydrogen content in Al melt for a given hydrogen partial pressure,  $S$  is expressed as

$$\log S = 2.796 - 2760/T + 1/2 \log p_{H_2} - \log f_H$$

where  $S$  has units of ml/100gAl and  $T$ ,  $f_H$  are absolute temperature and alloy interaction parameter, respectively

Working principle of Park-Rapp probe



## Probe

The sensor is a YSZ tube itself attached with a doped calcium zirconate (proton conductor) which has a high thermal shock resistance. It is then brazed with KOVAR which is subsequently welded to a stainless steel tube to prevent from hydrogen gas leak. The WE (working electrode) is protected from Al melt by covering with porous graphite and Al seal is adopted to prevent from oxidation during the cooling period. The probe responds fast enough that it takes about 3-5 minutes to complete the measurement.

The probe has long life time. It can be used until it breaks. But we recommend to calibrate it once in a three months or 100 times use. If it is malfunctioning by some reasons, analyzer recognizes it immediately to give a error-notice to the user.

The probe(20cm long) is equipped with a handle (40cm long) which is then electrically connected to the analyzer. Thermocouple installed in the handle acts as a reference electrode as well as temperature sensing for the WE of the sensor.

## Specifications

Measuring Range : 0.05-0.4 ml/100gAl

Accuracy : ±0.05 ml/100gAl or ±15%  
(whichever is greater)

Reproducibility : <0.01 ml/100gAl or ± 10%  
(whichever is greater)

Measuring Time : <5 min.

Max. depth of Immersion : 70 mm

Operating Temp. : 600-700 °C

Size: 120x244x46 mm

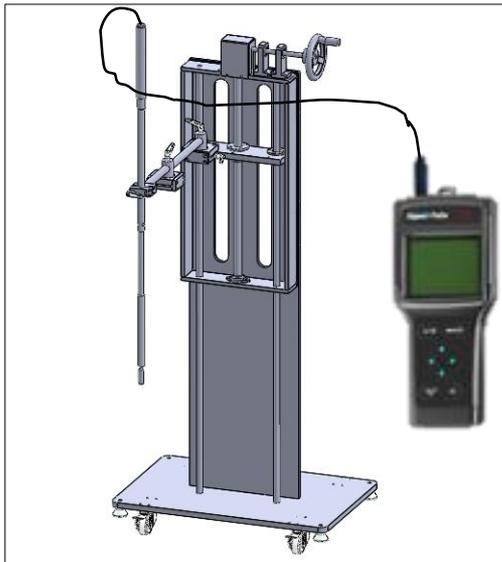
Weight : 510g



## Probe Stand

For the convenience and safety purposes, we recommend to use probe stand when the AlproH Palm-measurement is made by inserting the probe into the hot melt. It is made to grasp the probe firmly with two armed grip which can move up-and-down by a manual screw action. It also provides with a cooling pad which enables the temperature of the heated probe to drop rapidly after taking out the probe from the melt.

Because the probe stand is made of Al alloys, it is light in weight and easy to deploy.



## Fast, Accurate, Easy to handle and Long Life

Due to the use of patented air reference electrochemical sensor along with special measuring algorithm, the probe gives a fast reading in <3 minutes and a solid firm structure can be possible to make it immune to any mechanical and physical problems.

The graph below shows the time to obtain an EMF output from the probe in the melt test and how to convert it into dissolved hydrogen content.

