How to choose contact angle meter (goniometer)

or contact angle measurement instrument

(drop shape analysis system)

Keywords: contact angle meter, price of contact angle meter, low cost of contact angle meter, measuring method of contact angle meter, principle of contact angle meter, contact angle measurement, contact angle measurement instrument

Describe: There are a lot of contact angle meters or contact angle measurement instruments with different measuring methods, made by different manufactories. And quality and working accuracy of these contact angle meters or contact angle measurement instruments are quite different from each other. How to choose the most suitable contact angle meter for us is more important.

There are a lot of contact angle meters or contact angle measurement instruments with different measuring methods or made by different manufactories. And, quality and working accuracy of these contact angle meters or contact angle measurement instruments are quite different from each other. How to choose the most suitable contact angle meter for us is more important. This article will show you how to begin your contact angle measuring experience by choosing the most suitable contact angle meter from different manufactories in worldwide.

1, Startup choosing contact angle meter from *What material do you want to measure and what's your purpose to measure contact angle*?

Material which you want to measure is always taken seriously when one choose contact angle meter. Actually, material such as fiber (especially measuring contact angle between resin and single fiber, or single fiber with super-hydrophobic surface), powder (with contact angle above 80 °) and uneven surface is difficult to measure contact angle. All of these need special ways to measure contact angle. (Email us to get more information about measurement of contact angle for these conditions)

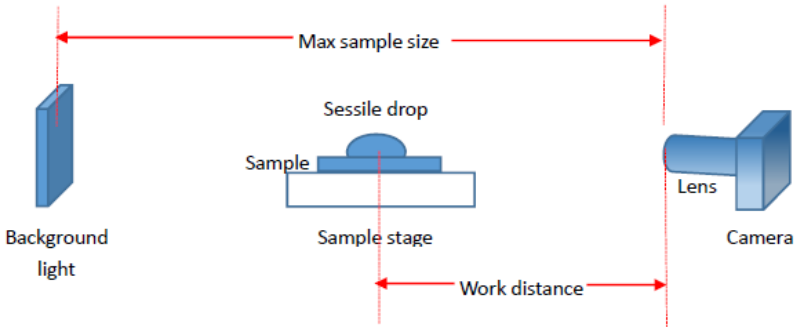
Material with Super-Hydrophilic (contact angle below 3 °) surface (such as aluminum foil of air conditioning) or super-hydrophobic (contact angle above 140 °) surface (such as lotus leaf or water strider leg) is also difficult to measure contact angle. General method of contact angle meter is useless in this condition.

So, when you measure such material as described above, you should tell it to your supplier and ask them for a suitable solution.

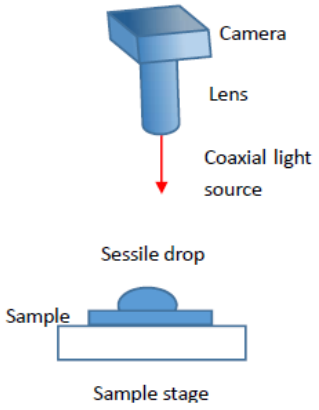
The second thing we should consider is outline dimensions of measuring sample, especially size of one side and thickness of sample, because to capture small droplet image, work distance of lens is usually not very long (max. work distance of lens with 0.20X auxiliary lens is about 360mm). And commercial contact angle meter, work distance of lens is usually about 170mm and it can be used to measure

contact angle of sample with size of one side about 300mm. As an alternative when we measure contact angle for especially large sample such as LED displayer, we use prism to refract the observation angle and background light. (Refer portable contact angle meter model SL200P series).

The third thing that need to be considered is concave sample. Due to view of lens is side-looking, contact angle of concave sample cannot be measured using normal sessile drop method. We should use top-side view to measure contact angle of such sample and use ADSA-D method to calculate contact angle.



Side-looking for measurement of contact angle by sessile drop method



Top-side view for measurement of contact angle by ADSA-D method

2, Choose contact angle meter based on measuring method

There are about ten methods to measure contact angle (refer: surface science techniques, Gianangelo Bracco Bodil Holst editors, springer 2013, ISBN 978-3-642-34243-1, for more information). Including the following methods:

2.1 Direct measurement by telescope-goniometer:

This is usually called as contact angle goniometer. The most widely used technique of contact angle measurement is a direct measurement of the tangent angle at the three-phase contact point on a sessile drop profile. The first commercial contact angle goniometer is designed by W.A.Zisman, and was manufactured by Ramehart instrument company. Usually, contact angle meter with camera but without complexity algorithm (such as drop shape analysis system) is also called as contact angle goniometer. Most manufactory's contact angle measurement instrument is fall into this category except contact angle measurement instrument with drop shape analytical system. Refer 2.10 drop

shape analysis system for more information.

2.2 Captive bubble method:

Instead of forming a sessile drop on the surface of solid, an air bubble is formed beneath the solid sample, which is immersed in the testing liquid. This method is very useful for material with Super-Hydrophilic (contact angle below 3 °) surface (such as aluminum foil of air conditioning) or super-hydrophobic (contact angle above 140 °) surface (such as lotus leaf or water strider leg).

2.3Tilting plate method: This method is rarely used due to its poor precise and operation is inconvenient.

2.4Wilhelmy balance method:

The Wilhelmy balance method is a widely used technique that indirectly measures contact angle on a solid sample. The Wilhelmy balance technique is an indirect force method. It is usually used to measure dynamic contact angle of smooth and known wetting length. And sometimes, it is maybe an alternative solution when one want to check sessile drop method. Some manufactory that don't make optical method will always emphasize advantage of this method and ignore its disadvantage. So, we must be sure what we really want, then you will make a good choice.

It has several advantages over conventional optical methods. First, the task of measuring an angle is reduced to the measurements of weight and length, which can be performed with high accuracy and without subjectivity. Second, the measured force at any given depth of immersion is already an average value. Although this feature does not help determine the heterogeneity, it automatically give a more accurate contact angle value that reflects the property of the entire sample. In addition, the graph produced by this technique (Fig. 1.8) is useful for studying dynamic contact angle and contact angle hysteresis at different wetting speeds. The smoothness of the curve indicates the heterogeneity of the solid sample. It is even possible to study absorption or surface reorientation by repeating the submersion circle. However, the method also suffers from several drawbacks. The solid sample must be produced with a uniform cross section in the submersion direction. Rods, plates, and fibers with known perimeters are ideal samples, but it is sometimes difficult to measure the perimeter and the wetted length precisely. Other than regular geometries, the sample must have the same composition and topography at all sides, which might be difficult to meet, particularly if one wants to investigate films or anisotropic systems. Also, a sufficient quantity of liquid must be used, which might cause the solid sample to swell and/or absorb vapor unintentionally.

2.5Capillary rise as a vertical plate:

When a kind of liquid comes contact with a vertical and infinitely wide plate, it will rise due to the capillary effect. The height of capillary rise h can be determined by the integration of the Laplace equation

$\sin \theta = 1 - \Delta \rho g h^2/(2 \gamma lv)$.

This method is rarely used in commercial contact angle meter or any other contact angle measurement instrument.

2.6Individual or single fiber:

The above mentioned Wilhelmy balance method is probably the most reliable technique for measuring

contact angle on individual fiber of known diameter. The precise value of the fiber diameter can be determined by using a liquid of known surface tension to wet the fiber completely (i.e., zero contact angle). Given that cos θ = 1, the perimeter p of the fiber can be calculated from whilhelmy balance equation. Similar to the solid plate used in Wilhelmy balance method, a continuous immersion circle of the fiber in the liquid can also be used to test the homogeneity of the fiber surface.

But, for fiber with diameter about 5um, we usually use micro-balance with precise 0.001mg (1ug). It is more expensive.

Sometimes, this solution may be out of work due to liquid for test is viscosity or fiber is variable bended.

2.7Capillary tube:

In circumstances when both the inside and outside surfaces of the capillary tube are made of the exact same material, the Wilhelmy balance method can be used to measure the contact angle. The perimeter p of the capillary tube should be the sum of the inner and outer perimeters. In general, the Wilhelmy balance method can be applied to a wide range of plates, rods, wires, tubes, and capillaries.

2.8Capillary penetration method for powders and granules (Modified and extended Washburn method):

The capillary penetration method was developed by Washburn, who monitored the rate at which a liquid penetrates into a compressed powder cake. The measurement was achieved by recording the depth of the liquid front intrusion as a function of time. The contact angle can then be deduced according to Washburn theory:

$l^2 = rt\gamma lv \cos \theta/2\eta$

where l is the depth of liquid intrusion, γlv is the liquid surface tension, θ is the contact angle, η is the liquid viscosity, t is the time required for penetration, and r represents the pore radius. Numerous qualitative measurements have been performed, and the method has been developed theoretically.

But this method need to find a liquid that can form contact angle about 0 ˚on powder, and when measuring contact angle is above 90 ˚, this method is useless.

There are about 5 methods for measuring contact angle of powder. Email us for more information.

2.9Caplillary bridge method:

Restagno et al. developed a high-precision contact angle measuring technique, which they referred to as the “capillary bridge method”. In their experiment, a spherical solid surface (usually a watch glass) is put in contact with a large liquid bath. Due to the capillary effect, a meniscus or “capillary bridge” forms around the contact line, which defines the wetted area on the solid surface. The shape of this “capillary bridge” between the solid surface and the liquid changes as the solid is slowly moved up or down to give a systematically varying wetted area. By monitoring the changes of the wetted area and the distance that solid surface moves, the dynamic contact angle can be quantitatively determined through numerical resolution of the Young-Laplace equation or by a simplified approximated relation:

$A = 2\pi R(k^{-1}(2(1+\cos \theta))\ ^\wedge(1/2) - h)$

2.10 Drop shape analysis system:

Bashforth and Adams were the first to use the Laplace equation to analyze the shape of droplet profile. They manually generated a collection of sessile drop profile according to different values of surface tension and the radius of curvature at the drop apex. Consequently, the task of determining surface tension become simple interpolation from their tables. Their tremendous contribution lead to

booming development in the area. Blaisdell, as well as Tawde and Parvatikar extended the Bashforth and Adams tables. Fordham and Mills generated equivalent tables for pendant drops. Ever since digital computers become popular, drop shape analysis has been greatly improved, and many new methods have been developed.

Usually there are 3 generation of drop shape analysis system. Most manufactory's contact angle meter used Young-Laplace equation fitting method based on selected plane method (such as Kruss, Dataphysics, KSV, Ramehart, etc.)

Refer http://www.uskino.com/article/64.html for more information of drop shape analysis system.

3, Choose or build up your contact angle meter based on optical method by its functional module

Generally, contact angle meter (contact angle goniometer) is always consist of (1) Sample stage and its control system, (2) Dosing system and its control system, (3) Vision system and its control system, (4) Environment chamber, (5) Drop shape analysis software. So, choose contact angle meter for your purpose based on its functional module maybe a most useful way. And, you can also check out the rationality of contact angle meter's function design.

(1) Sample stage and its control system:

- Size of your sample will affect your choosing of travel range of XY direction if you want to measure all point located on sample surface.
- Which control system do you want? Manual control system or automatic control system that controlled by software?
- The weight of the sample. Some contact angle measurement equipment adopts rack and pinion dovetail stage, and its load capability is poor.
- Do you need rotating system for measurement of dynamic contact angle or thermodynamics intrinsic contact angle? Contact angle meter model SL200K and C60 are equipped this system as standard accessories.

(2) Dosing system and its control system

- Direct syringe pump or Multi-syringe pump? Later is for measuring surface free energy, and we use different liquid to measure contact angle in this case. But, later is contaminated easily due to it is difficult for you to clean the tube.
- Manual or automatic syringe pump. First one is cheaper and its dosing precision is also possible down to 0.02uL (with 100uL syringe pump).
-Manual or automatic transferring the drop to sample surface.
-If it has mechanical system corresponding to adjustment focus distance and position of needle?

(3) Vision system and its control system

- What speed of camera do you want? If you measure sample with super absorbent, you should choose high speed camera such as 100FPS or higher.
- The reliability and accuracy of measurement of contact angle or surface tension. If the budget allows, you can choose vision system with telecentric lens and parallel light background light to achieve higher accuracy of measurement contact angle or surface tension.

(4) Environment chamber:

- What temperature do you want?
- Do you carry out measurement of contact angle or surface tension under condition of pressure or vacuum?
- Do you need humidity environment?

(5) Drop shape analysis software
- What function do you want?
- Measurement of static contact angle or dynamic contact angle?
- Do you want to measure surface tension or interfacial tension by drop shape analysis software using pendant drop or sessile drop method?
- Do you want to calculate surface free energy?
- Do you want to measure dynamic surface tension or interfacial tension?

4, Simple difference between KINO's contact angle meter and other manufactory's

Please refer next PDF file.