An overview on how to analyse the wettability of contact lenses.

Contact lenses are more and more popular nowadays, as they are a convenient way to compensate for many typical sight problems. Assuring their safety, wearing comfort and good visual performance are key tasks for each contact lens manufacturer. A parameter that allows for the control and design of good contact lenses it´s surface wettability, because the ability of contact lenses to support a stable tear film layer determines a comfortable wearing experience. From now on, contact angle (CA) measurements have been widely accepted for characterizing the wettability of contact lenses. However, the CA values are significantly influenced by the employed measurement technique. The captive bubble technique was selected as the current ISO standard method to analyse rigid gas-permeable contact lenses but there is no standard method for soft contact lenses. For soft contact lenses, there are normally three techniques to perform CA analysis: sessile drop, captive bubble, or Wilhelmy plate (**Figure 1**). Each technique has its own advantages and disadvantages as explained in the following comparison.

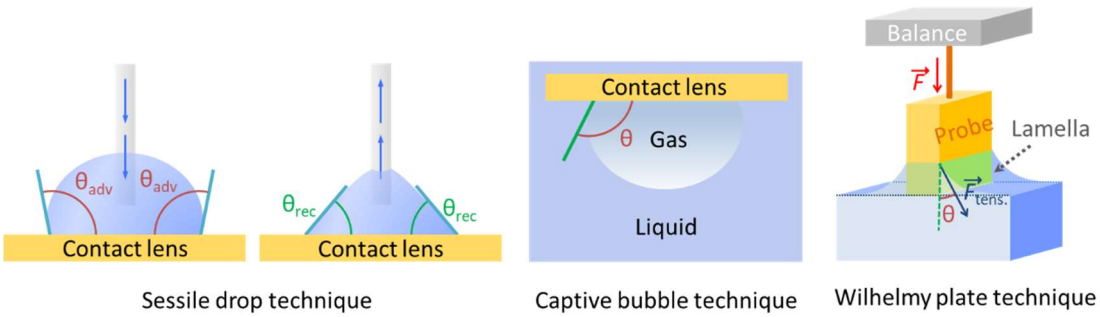

Figure 1: *Sessile drop, captive bubble and Wilhelmy plate techniques.*

Sessile drop technique

The sessile drop method is performed by using a syringe to place a droplet of liquid on the contact lens surface with an optical-based tensiometry technique. As Figure 1 shown, the CA is formed between the lens surface and the droplet. The instrument software can record and analyse videos and images of the experiments to obtain the CAs. The sessile drop technique has lots of advantages, for example, it is easy and quick to perform and able to measure both static and dynamic contact angles (DCAs), which is very useful to differentiate contact lens materials. The biggest problem for this method is however, that the lens and probe liquid are prone to uncontrolled dehydration during the measurement, due to the exposure of the lens to air which leads to alteration of the contact angle. In addition, typical soft contact lenses are highly hydrophilic so drops will rapidly spread leading to difficulties in result evaluation

Captive bubble technique

The captive bubble method is also known as an “inverted” sessile drop. The lens is submerged upside down in probe liquid (usually water) and an air bubble or immiscible liquid is placed on the lens surface to create a “droplet”. As Figure 1 illustrated, the CA is formed between air bubble and lens surface. A similar instrument software as for the sessile drop technique is used to collect data. Since the sample is suspended in liquid, it is not prone to dehydration. This experiment can be conducted in a static or a dynamic way. However, this technique is time consuming because it is difficult to align the bubble with the lens surface. Like the sessile drop technique, the analysis and data are somewhat subjective, as the CA evaluation depends on the selected analytical software models.

Wilhelmy plate technique

The Wilhelmy plate method is a force-based tensiometry technique. In this technique, attach a rectangular-shaped lens is hooked to an electronic balance and position above the liquid. At the beginning of the experiment, the lens weight is set to zero at the point where it almost touches the probe liquid. Then the lens is immersed to a set depth into the test liquid and withdrawn to the zero-force position. During a single measurement, this immersion/emersion cycle is usually repeated several times. As Figure 1 shows, the measured force is used to calculate the CA. The advancing CA and receding CA can be calculated respectively when the lens is inserted into and removed from the liquid. The difference between the advancing and receding CA is the CA hysteresis. Overall, this technique can provide more analysis information than the above two methods. However, the Wilhelmy plate technique needs a large amount of probe liquid and takes very long to collect and analyse data. Moreover, the sample preparation is complex and the lens is easy to be contaminated and torn.

Table1: Advantages and disadvantages of each method

Technique	Sessile drop	Captive bubble	Wihelmy plate
Description	Use a syringe to place a drop of liquid on the lens surface	Submerge the contact lens in liquid; Use a syringe to place small air bubble or immiscible liquid on the lens surface	Attach rectangular-shaped lens to a balance; Immerse and withdraw it from liquid
Advantages	• Quick and simple to perform • Static and dynamic contact angles	• Not prone to dehydration • Static and dynamic contact angles	• Provide more data about the lens • Lager area is analyzed
Disadvantages	• Lens is prone to dehydration	• Time-consuming and difficult preparation • Difficult to align the bubble with the lens surface	• Time-consuming • Subject to tearing contamination • Sample preparation is complex

Overall, each technique has its own features and drawbacks (Table 1). So far, sessile drop and captive bubble are the most commonly reported techniques for CA wettability studies of contact lenses. But the results from Wilhelmy plate technique are most reproducible and more accurate. However, regardless of which technique is used, subjectivity always exists due to the user and the selection of analytical models. It is important to provide the experimental details, such as the method that is used to calculate CA, drop size and humidity. As there is no recognized standardized technique for measuring the soft contact lens CAs, it would be very helpful to adopt more than one method to measure the CA of a new contact lens material, but in most cases only one technique is used in the literature.

For more information, please refer to the following article:

Applicability of CA Techniques Used in the Analysis of Contact Lenses, Part 1: Comparative Methodologies; Darren Campbell, Sarah Maria Carnell, and Russell John Eden; *Eye & Contact Lens* **2013**, *39*, 254–262. DOI: 10.1097/ICL.0b013e31828ca174