Wettability of contact lenses

Wettability can be defined as an ability of the liquid to spread on the solid surface. When a liquid spreads wettability is termed to be good, but if the liquid beads up the wettability is poor. Contact angle value of 90° is typically considered as a threshold value **(Figure 1)**.

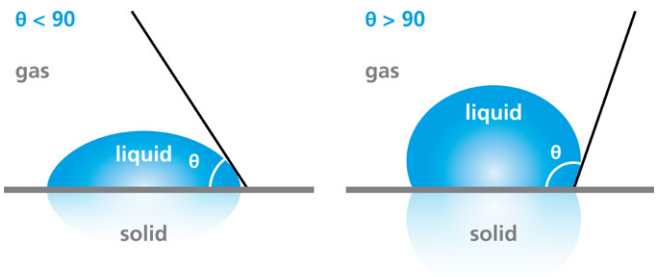

Figure 1
Good wettability (left), poor wettability (right)

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Wettability is especially important to contact lenses as the lens surface should support a continuous tear film. Poor wettability of the contact lens is related to reduced visual performance, an increase in surface deposition and discomfort. A recently discovered material for contact lens manufacturing is the silicone hydrogel, which is suitable for long-term use as it has improved oxygen delivery on the ocular surface. However, this material has been reported to have reduced wettability compared to other materials used in hydrogel contact lenses. This reduced wettability has been addressed with different types of surface treatments and coatings while trying to maintain a good oxygen permeability. Plasma treatment has been a popular choice to increase the hydrophilicity of the lens. Different coatings have also been common [1]. To study the effectiveness of surface treatments, the wettability of the contact lens needs to be evaluated.

Wettability can be evaluated through contact angle measurements

Contact angle is a measure of wettability and is also a widely accepted method for wettability evaluation of the contact lens. The contact angle is measured at the three-phase contact point where solid (contact lens surface), liquid (tear film) and gas (air) meet.

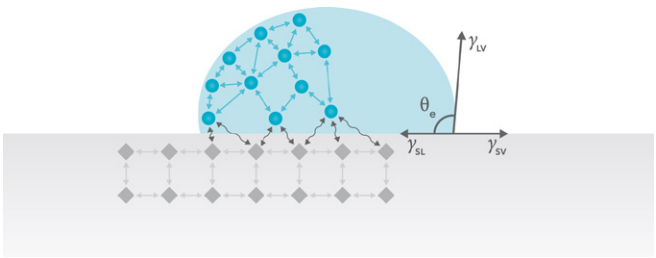

Figure 2
Contact angle is determined by the three-phase contact point where solid, liquid and gas meet.

Contact angles are often said to be either static or dynamic depending on whether this three-phase contact point is in motion or not. The dynamic contact angle is further divided into advancing and receding contact angles. Advancing contact angle is measured when the liquid front is moving across the air-exposed lens surface and receding when the contact line is withdrawn back. The difference between the two contact angles is contact angle hysteresis.

Receding and advancing contact angles are both important measures of contact lens wettability. The advancing contact angle develops when the eyelid closes and the tear film on the lens starts to recover. A receding angle forms when the eyelid is opened and the tear film starts rupturing on the lens.

Captive bubble method to mimic a real-life situation

There are three commonly used methods to measure contact angles; sessile drop, captive bubble, and Wilhelmy plate. Wilhelmy plate offers an automated method for dynamic contact angle measurements but it is not well suited for contact lenses due to shape requirements for the sample. A sessile drop is the most commonly used static contact angle measurement technique and can be used for dynamic measurements as well. The main problem with the sessile drop method in the case of contact lenses is that the measurements are done in air and the surface of the lens needs to be dried prior the measurements which can alter the surface.

Captive bubble method offers the best technique to mimic the real-life situation. The contact lens surface is immersed in a liquid throughout the measurement process and thus does not undergo dehydration. An air bubble is used to measure the contact angles. **Figure 3** shows an air bubble on contact lens surface immersed in water.

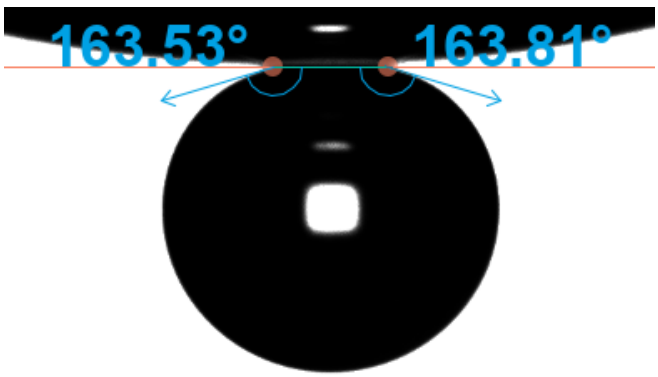

Figure 3
Captive bubble measurement on a contact lens.

Conclusions

Wettability is one of the most important factors when considering the surface properties of the contact lens. Wettability can be linked to biocompatibility and comfort. Contact angle measurements, and especially captive bubble measurements, provide a simple method for wettability evaluation of the contact lens.

[1] Wagner, H., "Polish up your practice: Today's contact lens surfaces", Review of Optometry Aug 15 (2018) 36.