



### **Advancing and Receding Angles of Biomedical Polymer Catheters**

Contact angle measurement by means of extension and contraction methods can be used to determine both advancing and receding angles. The advancing angle is the maximum contact angle possible for the liquid/solid surface system without increasing the interfacial contact area when the drop volume continuously increased. The receding angle is the minimum contact angle possible for the liquid/solid surface system without reducing the interfacial contact area when the drop volume continuously decreased. The difference between the advancing and receding angles is called contact angle hysteresis. The advancing and receding angles are sometimes referred to as dynamic contact angles because they can provide extra useful information in dynamic nature over static contact angle. For example, a small advancing angle is preferred in spin coating process for easy spreading of coating materials while a large receding angle is desired for chemical cleaning solutions for speedy drying up after the cleaning.

In the extension method, a droplet is first deposited on the sample surface. More liquid is then dispensed into the droplet and the contact angle is recorded over time. Eventually, the base of the droplet expands outward to compensate for the increase in droplet volume. The point where the base of the droplet starts to slide outward is where the advancing angle is recorded.

The contraction method is the extension method in reverse. Instead of adding liquid to the droplet, liquid is removed from a prepared droplet. Just as in the extension method, there comes a point where the base of the droplet begins to move inward. This point is where the receding angle is recorded.

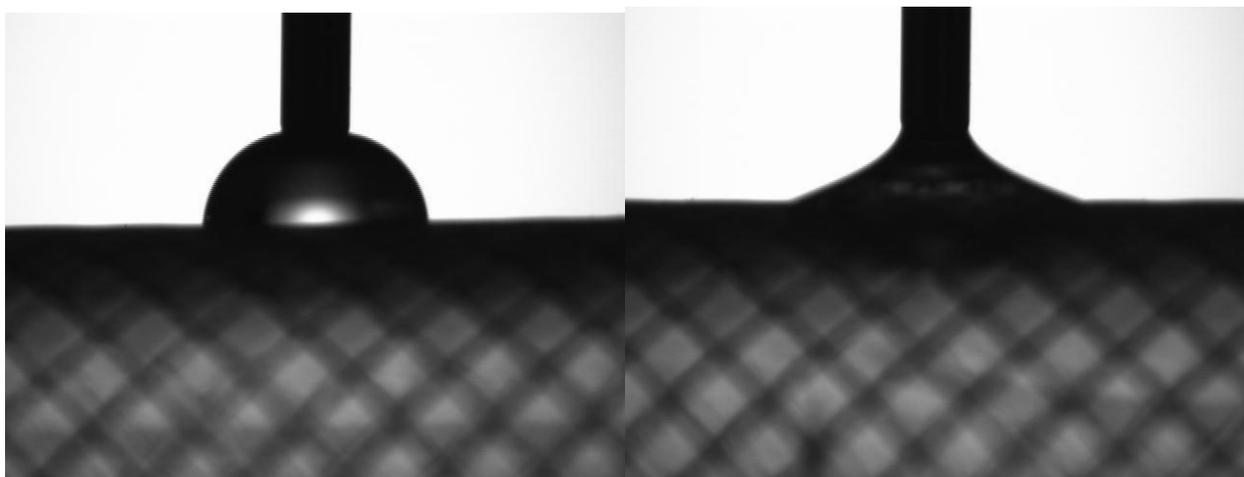


Figure 1. Images captured during advancing (left) and receding (right) angle measurements on the biomedical polymer catheter surface.



To perform the extension and contraction methods manually for advancing and receding angle measurement requires skill and steady hands. On the contrary, the DM-701 Contact Angle Meter, manufactured by Kyowa Interface Science Co., Ltd. is capable of performing the dispensing and aspiration of the liquid needed for the extension and contraction methods automatically. This automation minimizes the operator's error and improves measurement repeatability significantly.

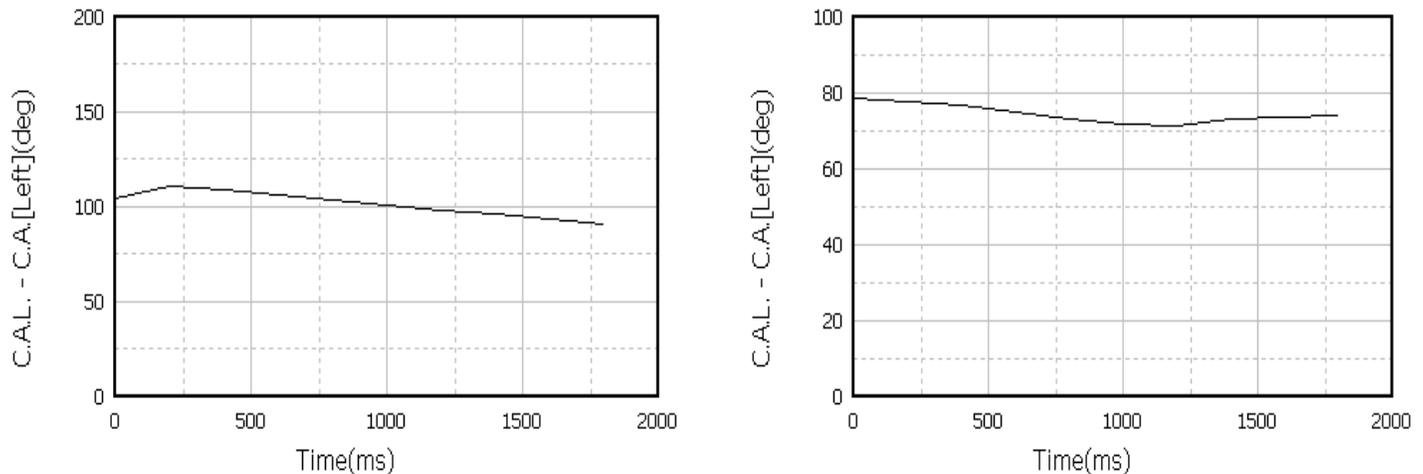


Figure 2. Contact angles measured over time through extension and contraction methods for advancing (left) and receding (right) angle determination of a biomedical polymer catheter.

In biomedical industry, catheters are often surface modified or coated to be lubricious and hydrophilic. Advancing and receding angles are measured for catheter surfaces in order to meet product specifications as well as to control interactions between catheter and patient body fluids during operation.

An uncoated biomedical polymer catheter tube was tested using the extension and contraction methods in our lab on the Kyowa DM-701. Some of the measurement results are presented in Figures 1 and 2. After the testing, it was found that the advancing angle was  $110^\circ$ . This is shown as the peak value in contact angle vs. time graph in Figure 2. The receding angle was  $72^\circ$ . It is shown as the minimum value in the receding angle vs. time graph in Figure 2.