# Contact Angle Measurements on a Fine Metal Grid

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Contact angles are well established as a sensitive means of contamination detection on surfaces. These measurements are straightforward on flat, solid surfaces and can be extended to curved surfaces with a little effort. When the surface is either

- rough, e.g., a medium grit sandpaper
- a fabric of fibers
- perforated with holes

then it is composite in the sense that it alternates between air and substrate as one moves microscopically across the surface. It is important to understand that the contact angles reflect the composite material and not just the original solid substrate.

The example at hand is a fine pattern metal grid then formed into a small tube. This note will detail *how* to measure a contact angle on such a sample. But first, let us discuss *what* the measurement does and does not mean. The measurement

- does not measure the metal contact angle
- does measure the composite surface
- is affected by the grid pattern
- is affected by the metal surface energy.

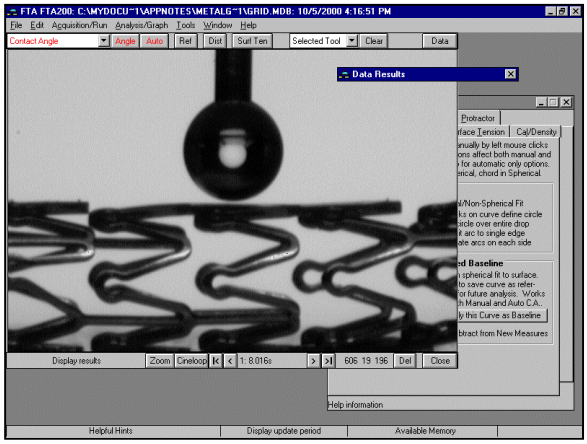
The measured contact angle shows the combined effect of the holes in the pattern and the metal contact angle. Finally, we assume the deposited drop is large enough to bridge the gaps in the pattern, so the drop will actually rest on the surface. Given this, the contact angle

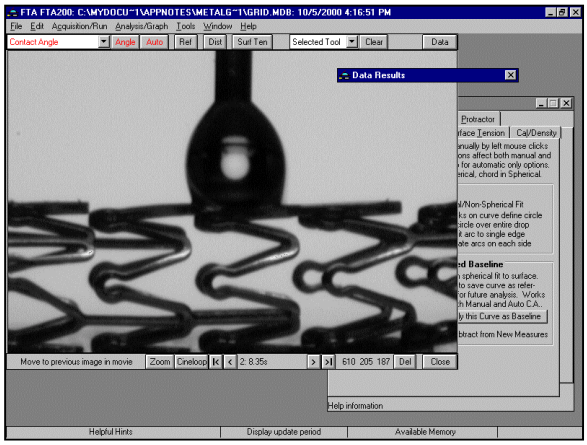
- directly and truthfully represents wetting behavior of the structure

- comparatively measures cleanliness or surface energy of the metal in the grid.

**Example**

The following sequence of images shows a test drop of water being deposited on the sample. A pendant drop is formed and then touched off onto the sample. In this particular case, the sample is lowered rather than the dispense tip raised.

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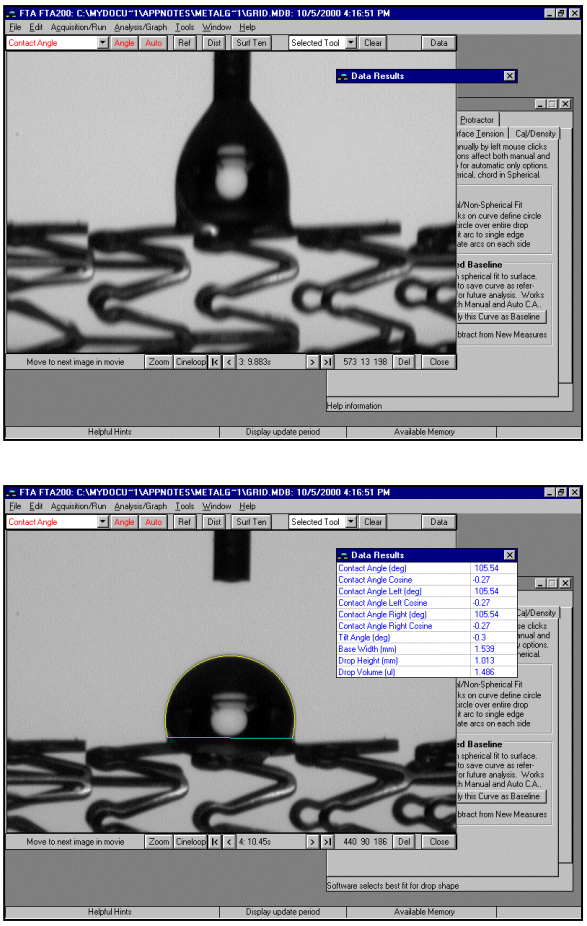


Sessile Drop on Metal Grid

Careful measurements on reference materials such as PTFE have shown this deposition technique to give the correct advancing contact angle because excess fluid flows from the dispense tip during the time the drop is pulling away from the tip (i.e., during the second and third images in the sequence). This excess fluid forces the drop to expand, if ever so little, and in so doing ensures that the angle is advancing.

The measured contact angle in this example is 105.5°. For a solid surface, this would be relatively high. For example, PTFE falls in the range 110 to 115°. However, for perforated or woven materials, it is not particularly high. One might ask: why do such materials have higher contact angles?

The answer lies back in Young's equation and the understanding that *any* spreading of the liquid on the substrate surface represents *adhesion* to that surface. But air gaps offer no adhesion, so the composite surface has regions which offer adhesion (the metal grid in this example) and portions which do not (the air gaps). The final contact angle is a balance between the two. Changing the gap size will change the ratio and change the contact angle.

As an aside, in many situations, like the design of a waterproof fabric, there must be enough material present to keep drops from penetrating (because the liquid adheres to the material), but it is the small air gaps which provide the other desired characteristics of low adhesion (low wettability), light weight, and thermal insulation.

**Summary**

Contact angle measurements on grids, fabrics, and composite surfaces offer excellent means of measuring wettability and surface cleanliness. Remember these measurements are comparative and that drop size relative to opening, or pore, size will affect the measurement when the pore size is not small compared to the drop. In such cases a constant drop volume should be used so the same ratios are in effect and comparisons are valid.