First Ten Ångstroms

JAI M30 Camera on the FTA4000

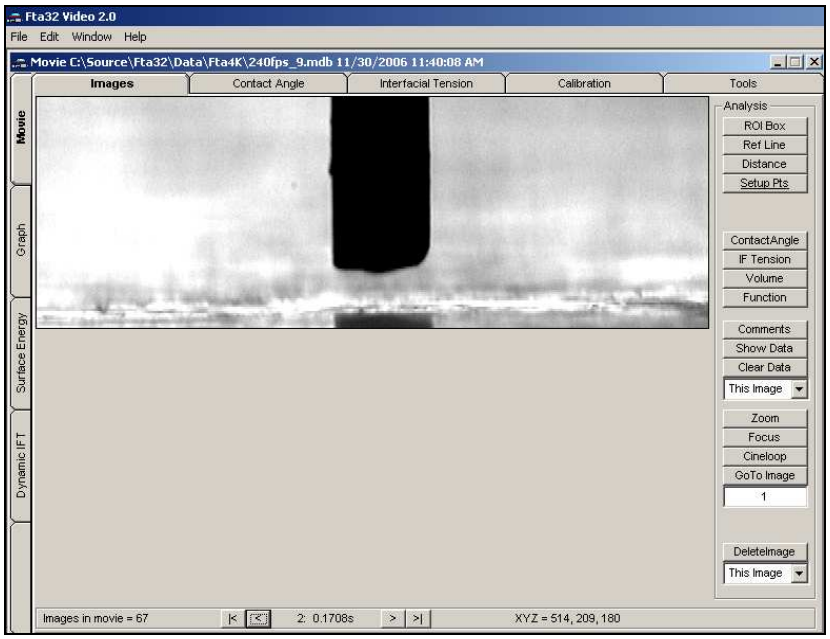
December 4, 2006

The JAI camera makes a nice addition to the FTA4000. This application note illustrates two different sample types: an aluminum surface, obviously non-absorbing, and a very absorbent paper (Epson ink-jet paper purchased commercially).

The JAI camera can run at several frame rates from 30 fps to 360 fps (frames per second). Image rates above 120 fps require smaller formats. The vertical height of the 240 fps image is ½ that of full height and the 360 fps is 1/3. The examples in this note use 240 fps as a reasonable compromise between field of view and frame rate.

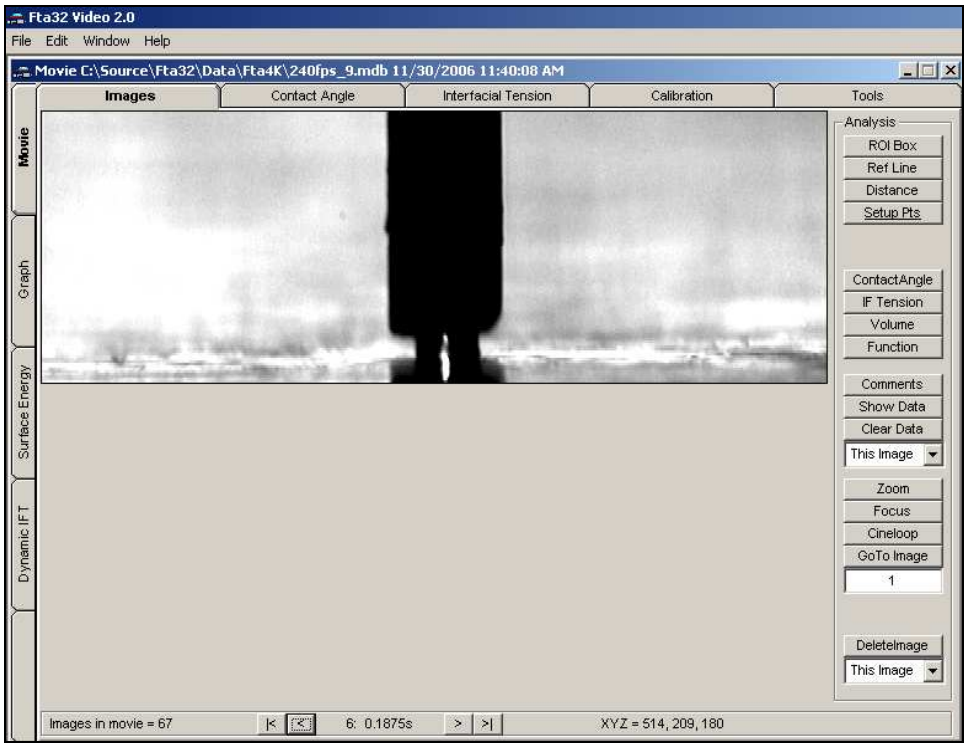
Aluminum

The next five images show the FTA Nanodispense touch-off of a sessile drop on an aluminum surface. Notice that the camera has a slight look-down perspective that allows it to see a reflection image. While common in ordinary slow-speed work, it is much more difficult to obtain satisfactory lighting brightness with the combination of higher speed (240 fps) and magnification (the field of view is 1.3mm and the tip diameter is 202µm).

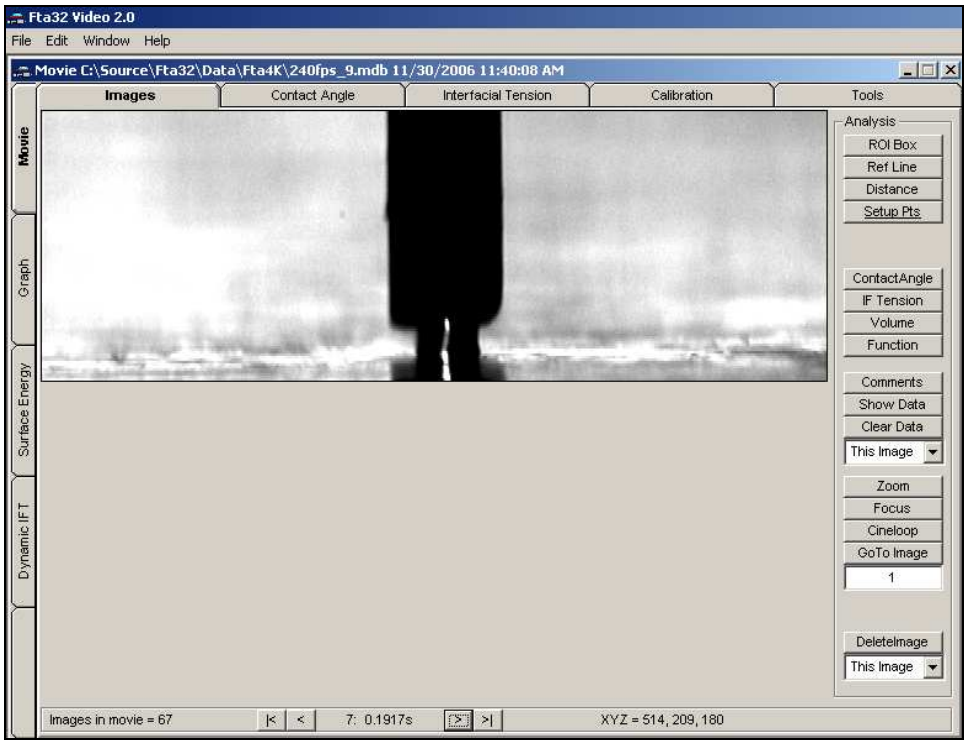


Tip above sample prior to touch-off. Tip motor position controlled automatically by image processing. Reflection image of tip can be seen at bottom of image.

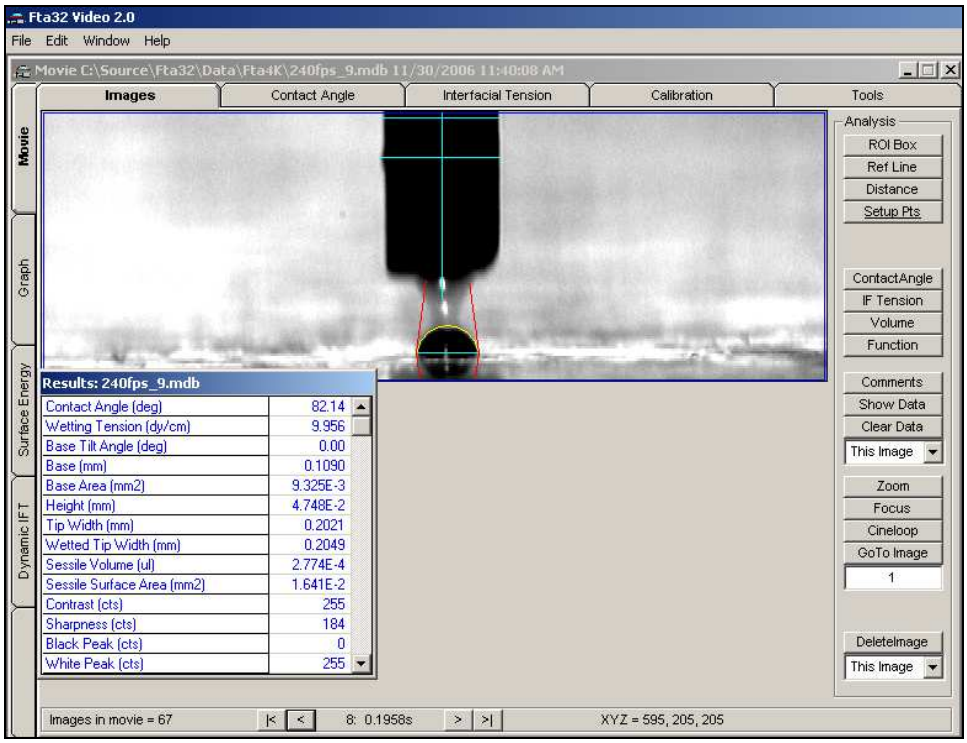
465 Dinwiddie Street • Portsmouth, Virginia 23704 • 1.757.393.1584 Fax: 1.757.393.3708
http://www.firsttenangstroms.com



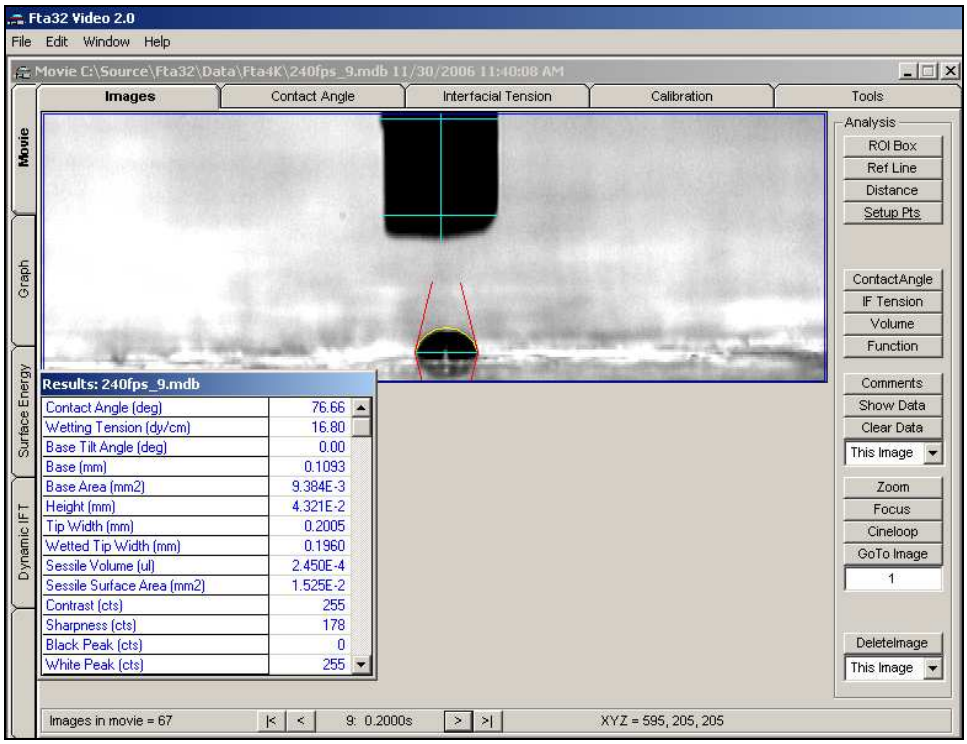
Tip has descended and liquid touches and adheres to surface.



Tip is now rising. This image is 4.2 milliseconds after the above image.



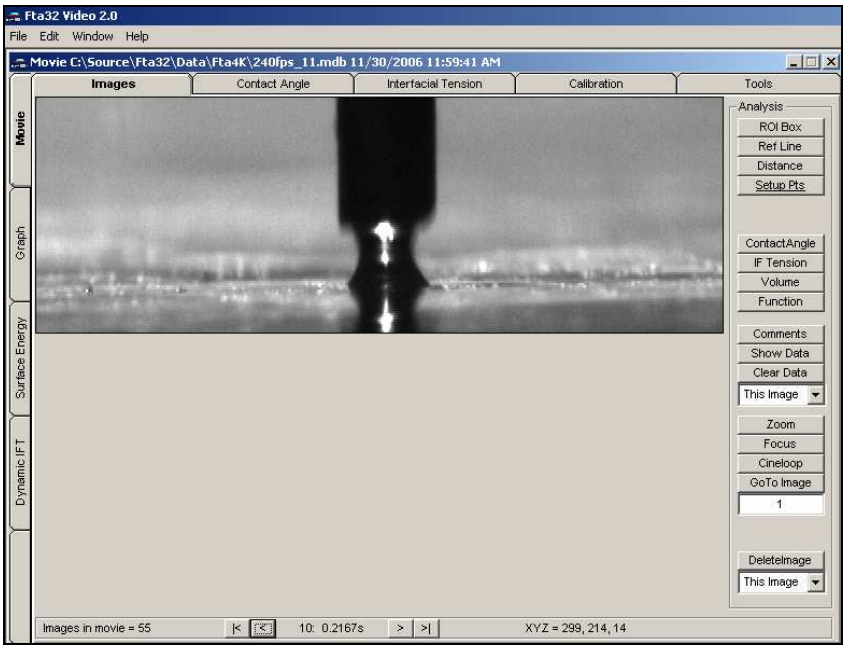
An additional 4.2 milliseconds has passed and the lamella between the tip's liquid and the sessile drop on the sample is breaking. Contact angle analysis is automatic. Sessile drop volume is 277 picoliters.



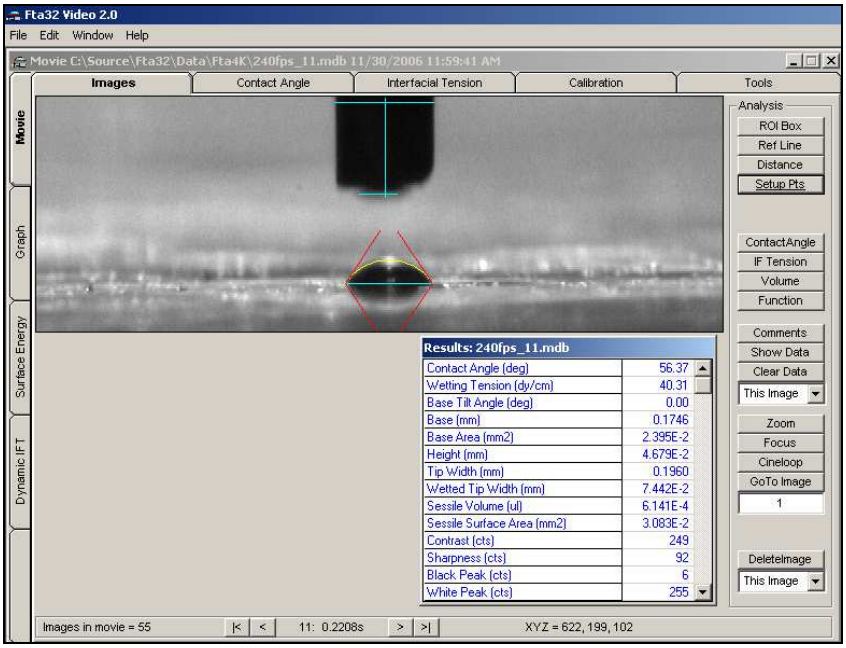
Again, an additional 4.2 milliseconds has passed since the previous image. The tip is now higher. Sessile drop volume starts to decrease as the water evaporates.

Ink-Jet Paper

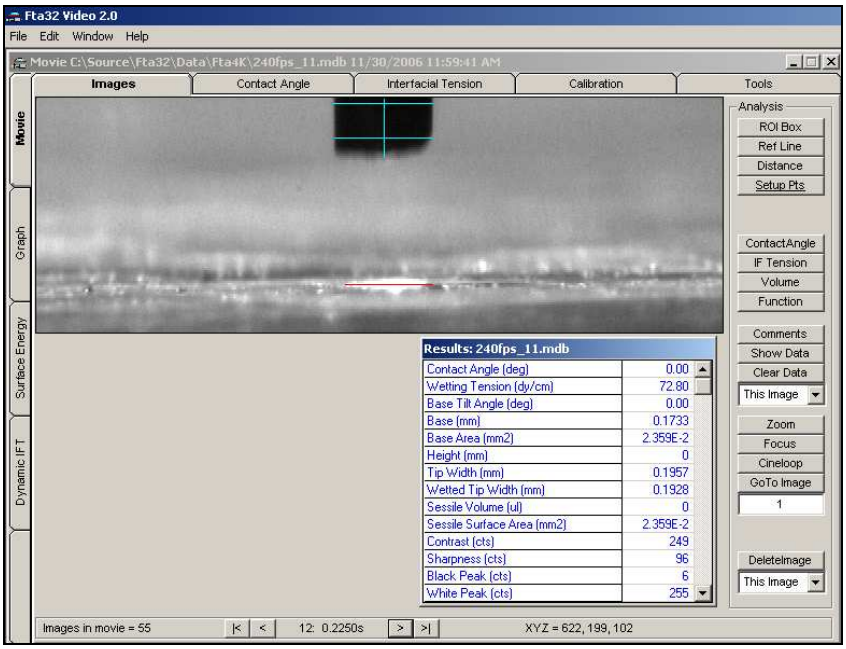
Water will absorb very quickly into this sample, as the next image sequence shows. Note the good image quality and high contrast in these reflection images. Contact angle analysis is automatic. The baseline between the liquid and the surface is determined by image processing in the deposition process, *before* the Movie is acquired. The time between each image in the sequence is nominally 4.2 milliseconds (more precisely, 4.16ms).



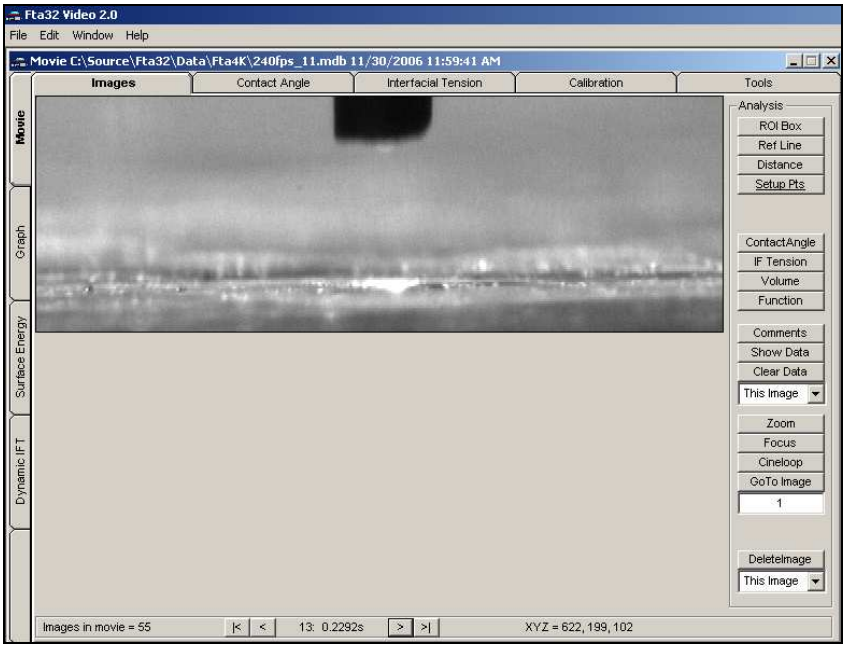
Lamella is about to break as tip rises, just as it did in the aluminum sequence discussed previously.



Sessile drop rests on paper. Volume is 614 picoliters. Automatic analysis.



Drop has absorbed completely! Here 360 fps might help a little. Note, however, that the contact angle analysis *automatically* determined the volume was 0.

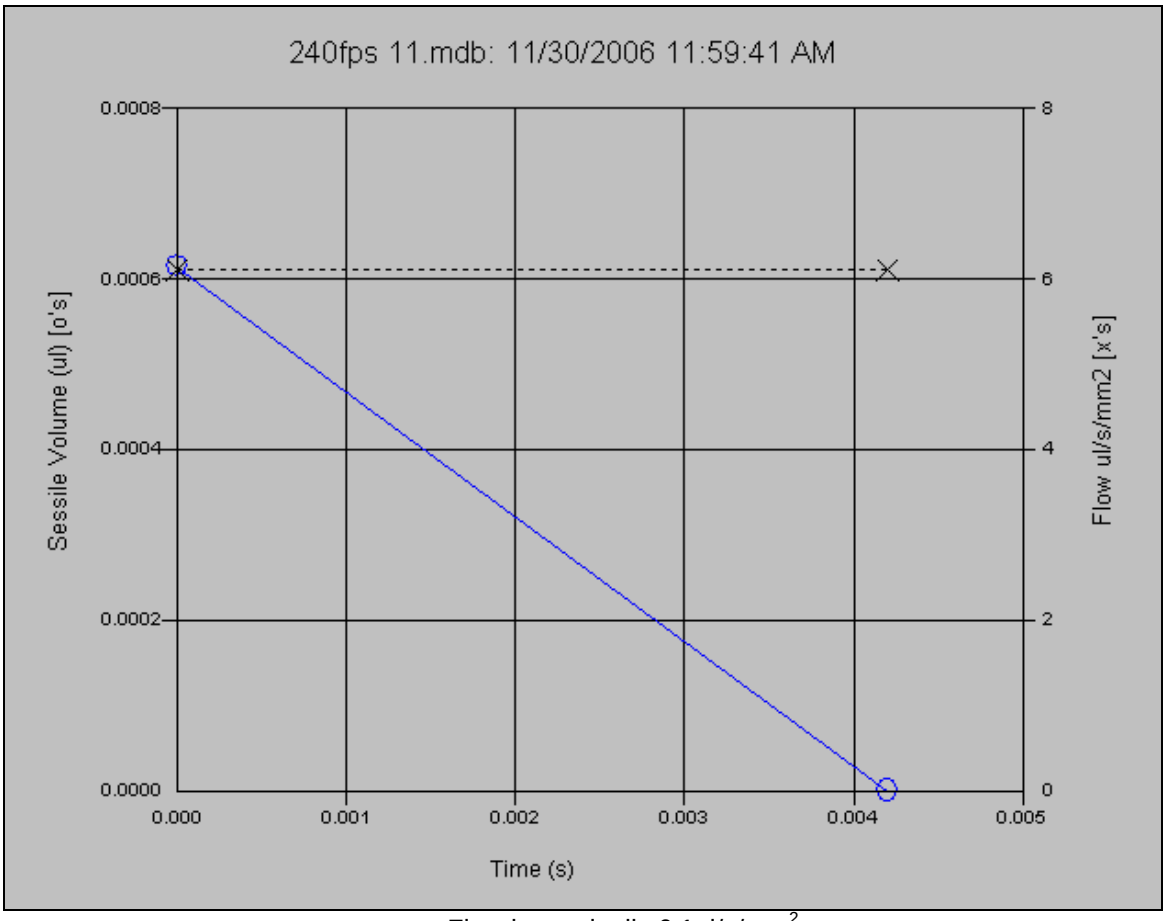


Next image. There is nothing but a wet spot where the drop was deposited. The contact angle analysis stops reporting data as it recognizes the previous image had zero angle and zero sessile volume.

The graph of sessile volume as a function of time is interesting. The left hand axis plots volume whereas the right hand axis plots *flow*, which means penetration of the sample liquid into the surface measured in

(microliters per second) per square millimeter of wetted sample

This is an extremely effect way of characterizing liquid penetration as it removes the influence of drop volume, as long as the sample does not saturate. Conversely, it can be used to show when the sample *does* saturate.



Flow is nominally 6.1µl/s/mm^2.

The flow calculation is robust in several ways:

- It can automatically function when there is only one positive-volume data point. While there is some uncertainty in when the volume actually went to zero –here is where a faster camera is helpful—inspection of several Movies showed it to be roughly 4ms.
- It contains averaging algorithms to handle the well-known *noise* in volume measurements over many images with slowly absorbing samples.

465 Dinwiddie Street • Portsmouth, Virginia 23704 • 1.757.393.1584 Fax: 1.757.393.3708
http://www.firsttenangstroms.com