

A Microscope for your Mobile Phone or Tablet

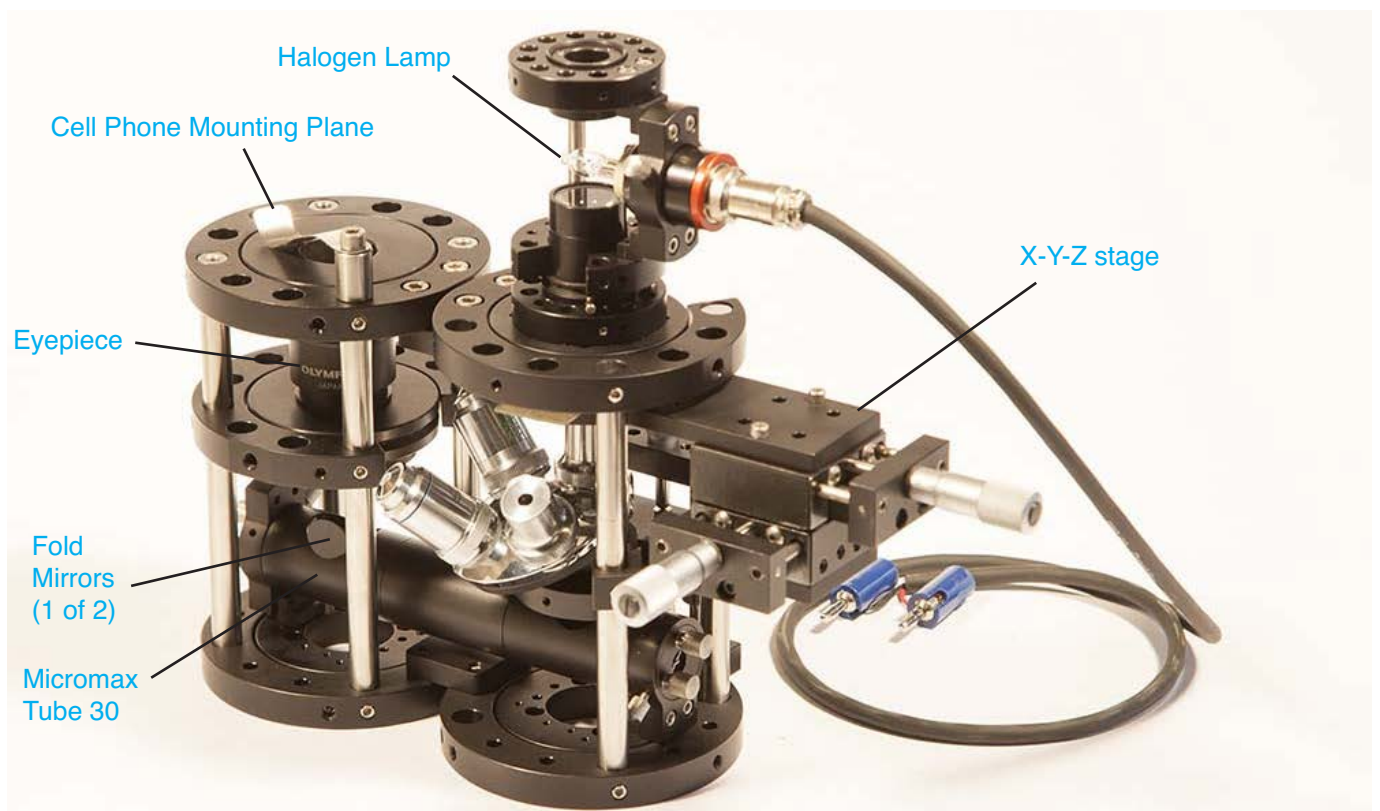
By Ali Afshari

In the last issue, I talked about the history of optical erector sets, and its progress to current state of art. In this issue, I will show you how to build an inverted microscope using Optoform. The same beam manipulation can be done with the cage system and Microbench, but I use optoform because it offers larger mounts to build the main body structure, and then use smaller mounts for beam manipulation. Recording an image through a microscope is not easy. Even with user friendly cameras. You'd need a trinocular viewing head, plus a digital camera, and then a laptop to capture, and be able to display it.



With a cellphone camera, one can easily take digital photos, and there is no need to use of external computers. You could zoom in for better focusing of image, take pictures, or videos, and you could immediately edit them, post them on the web, or email them. The idea is you could always take photos through a microscope using your cell phone or tablet by adjusting its lens distance with the eyepiece. This distance, and its centration is critical, and that's why most of these images would come out vignetted, tilted, or decentered. When building a microscope with a cage system, you'd need two mounts to secure the objective, and the eyepiece at a distance of 150 mm from each other (standard tube length). For the cell phone, we could also add a third mounting plate to adjust its distance from the eyepiece. To accomplish this scheme, an inverted microscope would be the preferred arrangement because of its folded tube length. In the normal microscope, the setup would be standing too tall, and it wouldn't be following good rules of optomechanics both for lack of its stability, and less user friendliness. So let's build this compact microscope, with inverted optics to make it super low profile. The cell phone could then be placed flat on its platform, and easily centered for taking pictures.

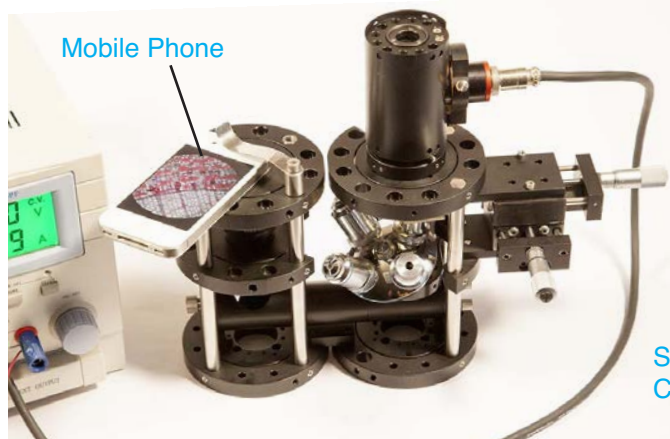
The ideal mount to build this assembly would be to use the Minoioptic mount 100. This is because its half diameter is 50 mm, and this is 1/3rd of 150 mm microscope tube length. Therefore, the beam could be folded twice using the Microptic mount 50 (see below).



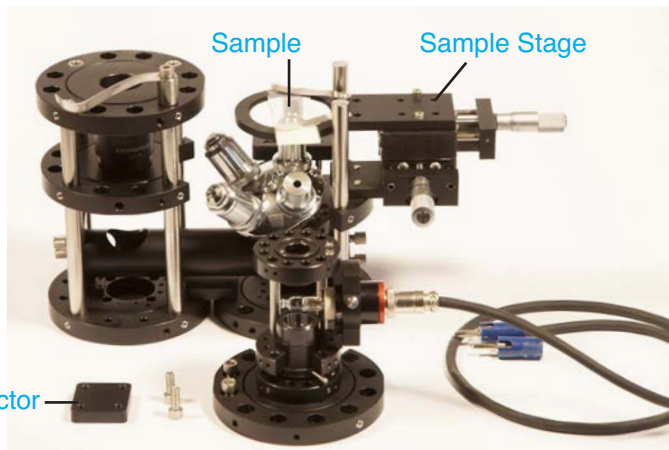
Design scheme of an inverted microscope built with Optoform system. The name Optoform refers to combining form, and function to build an optical instrument. Lamp cover has been removed to reveal condenser lens, and Halogen lamp.

If you notice, the side mounted orientation of mounts in our Optoform setup is arranged for all the hex screws securing the optics to be reachable for their centering adjustments. For square shaped Microbench, and Thorlab's cage system, the four-point mounting scheme prevents reaching the screws that are trapped in between the mounting plates. The idea behind using hex ball drivers in Optoform is to be able to reach hex set screws even at tilted angles. In actual practice, you'd find that Allen set-screws can not be inserted easily if inserted from an angle. But after they are inserted, ball drivers would become so handy to adjust them

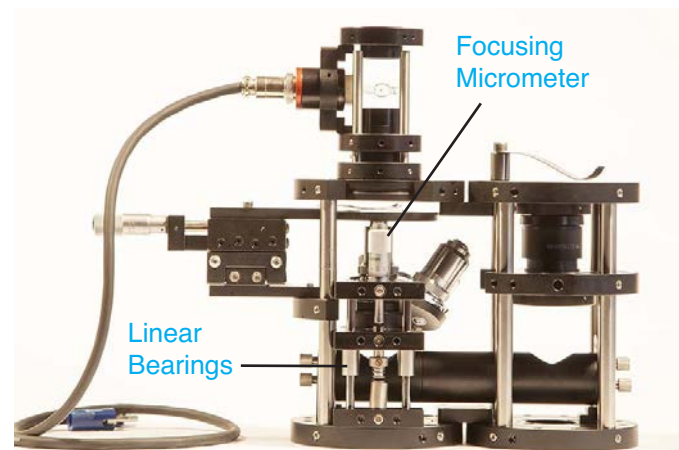
To conclude, Optomechanics is not an easy task. It takes skill, and general knowledge of natural laws governing nature. With Legos, you will have form but not function (when you build a boat, it will sink). Optical cage systems could give you both. You could build something just by following its optical path from a text book, and it would look, and feel like a microscope, a telescope, or an interferometer. Optoform has been designed to construct it with good form and elegance.



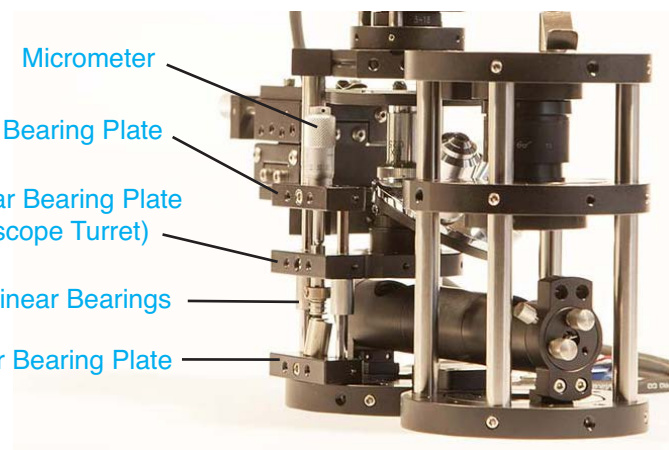
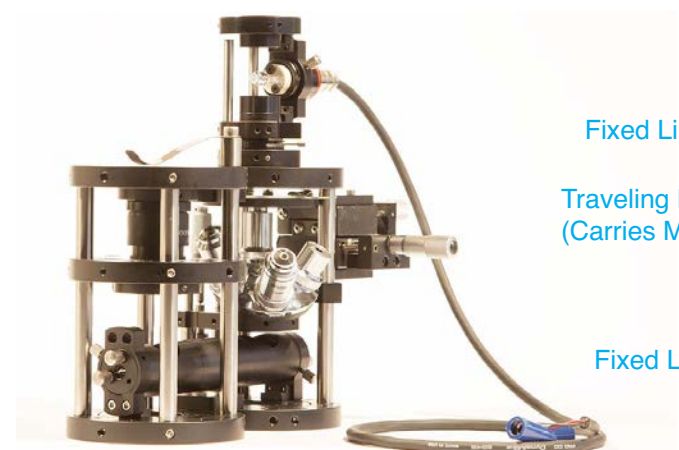
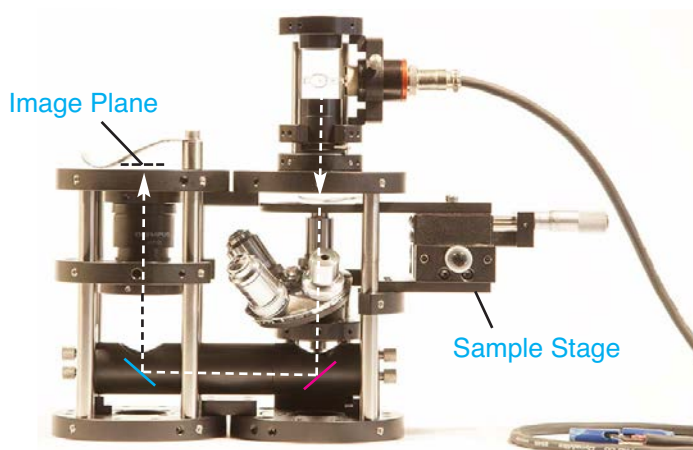
Mobile phone is shown seated above the eyepiece. The image can be centered, zoomed in, and captured.



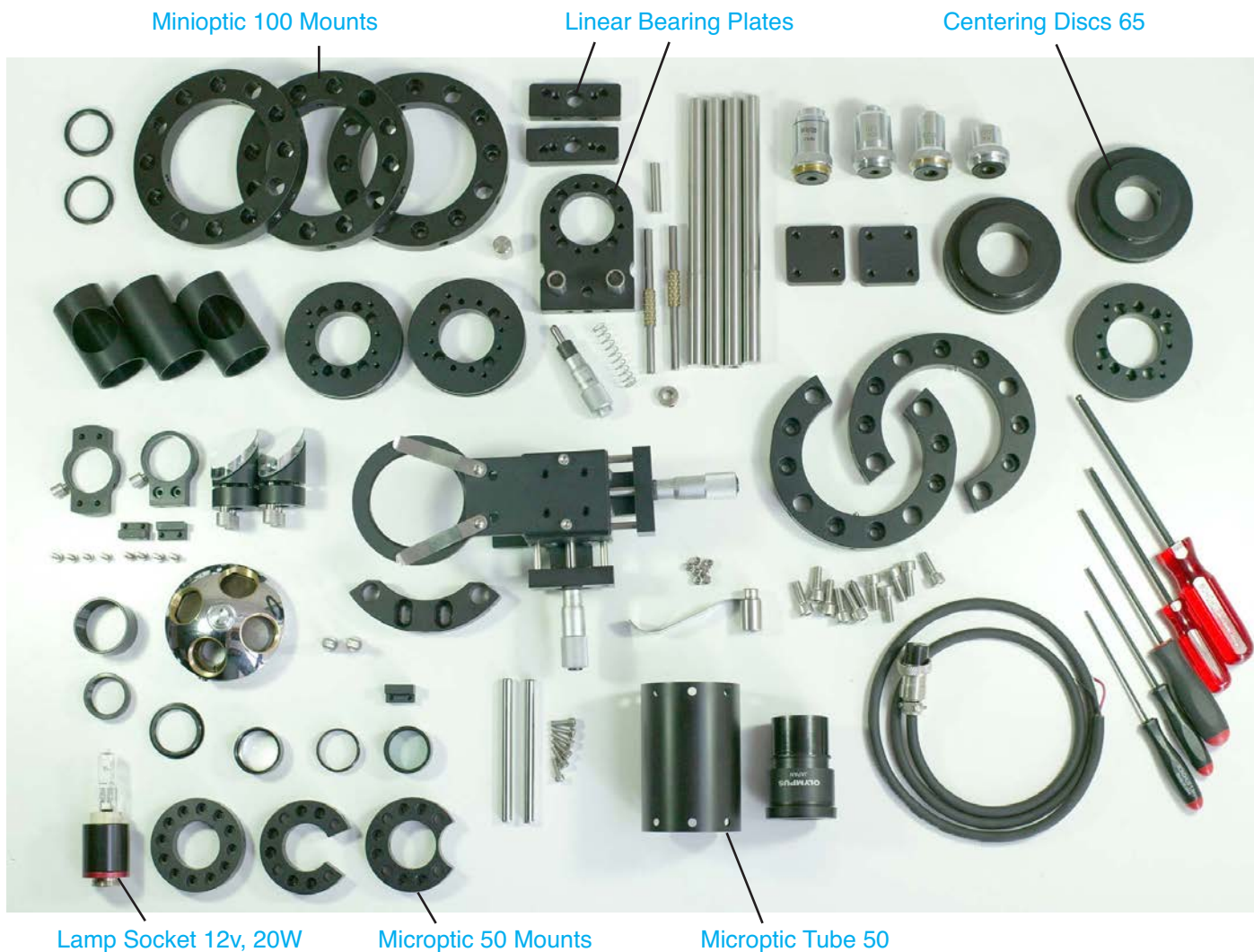
The illumination assembly is removed to reveal the sample holder platform.



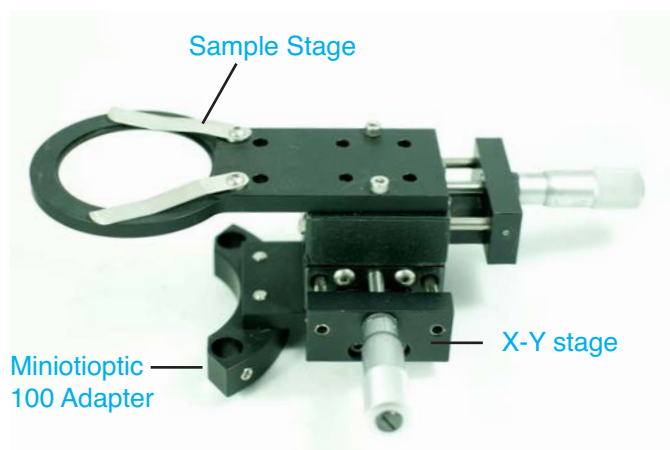
The light path is shown (above, left) emerging from the halogen lamp above the sample, passing through the sample, and reflected off of the first, and 2nd fold mirror, and going through the eyepiece to be focused to mobile phone camera.



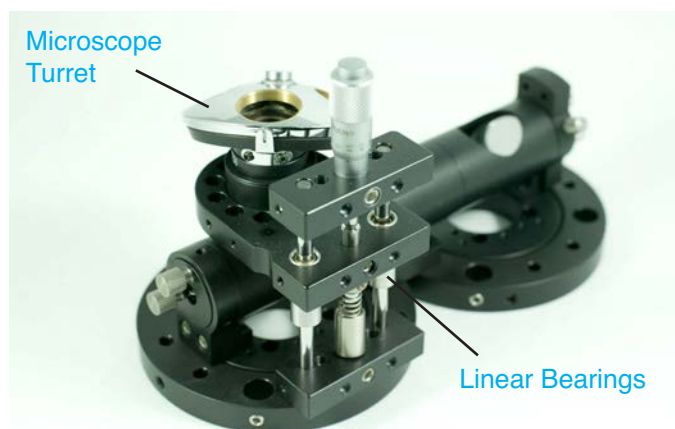
Linear bearing assembly for the Z-Axis is detailed here. The linear bearing is the heart of Optoform's flexibility. This particular assembly utilizes 10 mm Linear Bearings to handle the weight of microscope turret, with four objectives.



The parts list, and pricing for the inverted microscope assembly is available at optoform.com/microscopy. All the parts, and necessary optics are shipped together to the customer except the Microscope Objectives, and the eyepiece. The customer has the choice to add those at the time of placing the order. Microscope objectives have a diverse quality range from a few hundred Euros to a few thousands. The customer would decide the level of quality. The assembly time for the microscope is approximately one hour, and at that point, the end user will become quite familiar with Optoform assembly, and how to change its configuration to build their own design. Additional parts, and accessories can also be added.



The X-Y stage is designed for Optoform's Miniotic system 100 (100 mm O.D. mounts). The specimen holder has two securing spring plates, and has clearance for objective turret advancement. The X-Y stages is replaceable with motorized stages, with the choice of 12.5 or 25 mm travel range.



The microscope turret and fold mirrors are positioned in the compact space below the microscope body to reduce height. Thanks to the Z-stage with linear bearings, precise focusing can be achieved. The fold mirrors are covered with Micromax 30 tubing to keep away extraneous light from the field of view of the optics, and imaging device.