

Hysitron Triboscope Exam

Safety Considerations

- 1) What are the approximate (order of magnitude) purchase price of an AFM system and the cost to replace/repair a scanner head if it is damaged, respectively?
 - a. \$25,000-\$50,000; \$500-\$2,500
 - b. \$100,000-\$200,000; \$2,500-\$5,000
 - c. \$250,000-\$500,000; \$5,000-\$25,000
 - d. \$500,000-\$1,000,000; >\$25,000

- 2) What are the three most delicate/fragile components of the Hysitron TS75 Triboscope head? What is the approximate replacement cost of each? Do you have that kind of money? If not, where would the money come from?

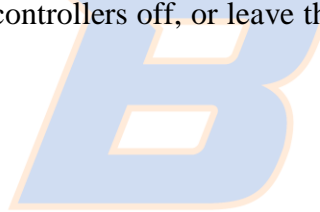


- 3) Which of the following could potentially break or damage these components?
 - a. Z motor pressing the tip into a sample with no feedback
 - b. Electrical shock from a static electricity discharge
 - c. Dropping the probe, transducer, or head
 - d. Applying a large voltage across the piezos

- 4) How much should you tighten the set screw that holds the transducer on the TS75 head?
 - a. What could happen if you overtighten it?

 - b. What if it's too loose?

- 5) How much should you tighten the diamond tip probe when attaching it to the transducer?
- What could happen if you overtighten it?
 - What if it's too loose?
 - What should you do to prevent cross-threading of the tip when screwing it onto the transducer?
- 6) You decide the PC running the NanoScope control software needs to be rebooted. Is it best to turn the AFM and Hysitron controllers off, or leave them on for the reboot? Explain your reasoning.



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- 7) We employ a Berkovich probe. What is its geometry (e.g., shape, number of faces, angles, radius of curvature)? Draw a sketch of an ideal indent made with a Berkovich probe.
- 8) Why is it customary/good practice to set the initial scan size to zero before engaging the surface?

- 9) As a general rule of thumb, what is the maximum indentation depth (expressed as a percentage of film thickness) you should use to avoid substrate effects when indenting thin films?
- 10) As a general rule of thumb, what is the minimum indentation depth (relative to surface roughness) you should use to minimize the effect of topographical variations on the contact area (and hence measured sample modulus and hardness)?
- 11) In general, should you mount your sample on a substrate that is stiffer or softer than your sample material? Explain your reasoning. How does this affect your choice of adhesive for adhering the sample to the puck/mount?
- 12) If the system keeps coming back as out of spec, the probe appears visibly dirty in the video feed, and/or you suspect the probe is dirty due to pileup or strangely shaped indents, what can you do to clean the probe tip without damaging it?

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Setup, Settings, & Operation

- 13) There are 4 cables (labeled A-D) that have to be attached when setting up the Hysitron TS75 TriboScope head. Briefly describe what each cable does (i.e., what electrical signals are being sent along the cable).

- 14) List the appropriate values for each of the following General Engage Settings. Give both the values employed during nanoindentation and what they should be changed back to following completion of your nanoindentation session. Include units!
- Sample Clearance
 - SPM Safety
 - SPM Engage Step
 - Load/Unload Height
- 15) List the correct values for each of the following parameters that should show up when you select the “Hysitron Emulator” profile.
- Microscope
 - Controller
 - Extender
 - Scanner
- 16) What microscope mode and feedback type must you select when using the Hysitron head?

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- 17) What is the purpose of the air indent? What type of feedback control should be selected within the TriboScan software?
- 18) The NanoScope software and controller provide feedback for the Hysitron TriboScope head when approaching, engaging, and imaging the sample surface. Only during the actual indentation do the Hysitron TriboScan software and Performech controller take over feedback.
- What should your default integral (I) and proportional (P) gains be in NanoScope?

- b. What should your default setpoint be in NanoScope? (Include units!) What does this roughly correspond to in terms of force?
- c. Why do you set the NanoScope gains to zero immediately before indenting, and why must you turn them back on as soon as the indent is complete?
- d. How can you tell if there is a breakdown in communication between the two controllers leading to no feedback during the engage process? If this happens, what should you do?

19) The Hysitron's calibration should be checked at the beginning and end of each nanoindentation session using a fused quartz standard.

- a. What are the accepted (literature) values for the Young's modulus and hardness of quartz? (Be sure to include units!)
- b. How close must the measured value of each be to the accepted value for the system to be considered "in spec"?

20) What values for the Hysitron (TriboScan) integral gain should be used in different load regimes? How can you tell if the gain is not optimal? (You may want to draw a sketch.)

- 21) What is the maximum force (load) that the Hysitron system can apply? Where can you find this value? What is the lower limit?
- 22) What is the maximum Z displacement of the TS75? (Include units!)
- 23) In order to carry out an indent, you must first set up a load function. Key components of the profile include the desired maximum load/force, the load and unload times, and an optional hold/dwell time at the max load. You must also specify the type of feedback control desired.
- Describe the load function used for the Calibration Air Indent.
 - Describe the load function used for indenting the fused quartz standard.
 - Draw a typical load-displacement curve. Be sure to label your axes and include units! Indicate the region used to determine the Young's modulus of the sample.



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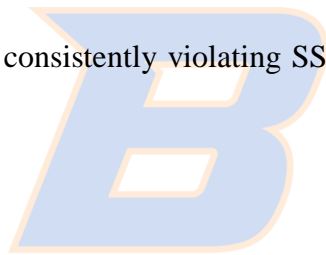
SSL Policies

- 24) What two things should you always do to minimize scheduling conflicts and ensure instrument time is properly accounted for? What should you do if you ever encounter a problem/issue with the Hysitron system?

25) What are the rules/guidelines regarding reserving instrument time (i.e., maximum number of hours, how far in advance, etc.)? What should you do if you need more time?

a. What if you're running late or can't make your time slot? At what point do you forfeit your reservation?

b. What is the penalty for consistently violating SSL policies? Why do we have these policies?



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