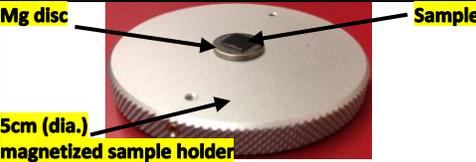


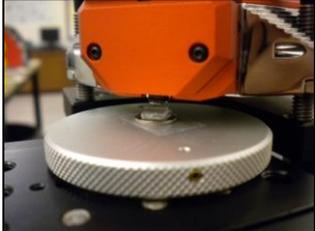
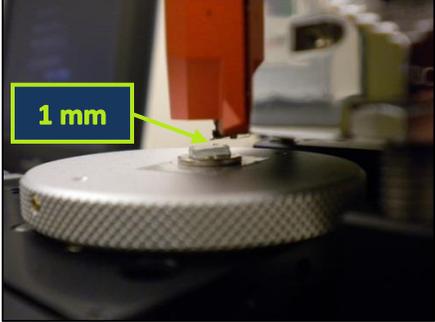
Number: 08**WORK INSTRUCTION BREAKDOWN SHEET**Operation: Atomic Force Microscope (AFM) **Operations**

Instrument: Nanosurf Easyscan 2 AFM

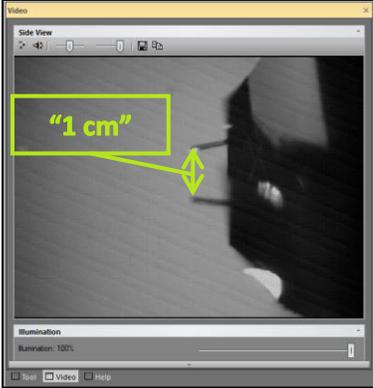
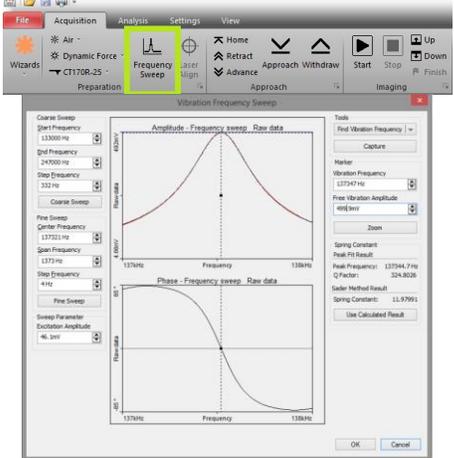
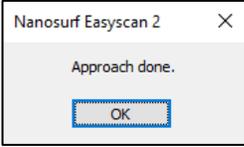
IMPORTANT STEPS	KEY POINTS	REASONS WHY
A logical segment of the operation when something happens to advance the work.	Anything in a step that might: <ol style="list-style-type: none"> 1. Make or break the job 2. Injure the worker 3. Be a Cultural Consideration 4. Make the work easier to do (i.e., “knack”, “trick”, special timing, or bit of special information). 	Reasons for each key point
Sample Preparation		
Put on clean, disposable gloves.		Minimizes contamination of samples and instrument.
Ensure sample is appropriate for characterization by AFM.	Check/measure sample features to verify they are within the instrument manufacturer’s tolerances: <ul style="list-style-type: none"> • For the Nanosurf Easyscan 2 AFM, exact values are shown on the calibration certificate delivered with the instrument; and • Generally, sample features that will be scanned are limited to a 50 µm x 50 µm area and surface should be “locally flat” with a height between 10 nm and 500 nm. • If uncertain whether the height of the sample’s features exceed this limit, Operator should first scan the sample in a different surface characterization instrument, such as a profilometer. 	The Nanosurf Easyscan 2 AFM can be used to examine any material with a surface roughness that does not exceed the height range of the scanning tip.
Ensure sample is clean and dry.	If sample is <i>not</i> clean and dry: <ul style="list-style-type: none"> • rinse sample with appropriate highly pure solvent such as distilled water, IPA, or acetone; and • carefully dry with clean/canned compressed air or nitrogen gas. 	Minimizes contamination of samples and instrument and prolongs life of cantilever tip.

<p>Load sample assembly onto AFM magnetized sample holder. (located on vibration isolation table inside black plastic AFM isolation box)</p>	<p>Perform these key points with tweezers as much as possible to minimize contamination (skip to the third bullet below if using an already-prepared sample):</p> <ul style="list-style-type: none"> • First, attach double-sided tape to 12mm magnesium (Mg) disc; • Second, firmly place sample onto disc+tape combo; • Finally, place disc+tape+sample assembly onto 5cm (dia.) magnetized AFM sample holder. <ul style="list-style-type: none"> • This final assembly is hereon referred to as the “loaded sample holder”. • If Operator needs to slide sample assembly to a different location on the magnetized sample holder, use rounded black plastic-coated tweezers. 	 <p>Image: Loaded Sample Holder</p>  <p>Image: Broad Tipped Tweezers</p>  <p>Image: Rounded Black Plastic-Coated Tweezers</p> <p>Using black plastic-coated tweezers minimizes potential to scratch the surface of the magnetized sample holder.</p>
<p>Return the loaded sample holder to the AFM vibration isolation table.</p>		
<p style="text-align: center;">Sample Placement and Instrument Preparation</p>		
<p>Open the Nanosurf Easyscan 2 AFM software.</p>	<p>The software icon is typically located both on the desktop (double-click) and in the bottom toolbar menu (single-click).</p>	
<p>In the Video Side View window in the right portion of the software, verify both the AFM scan head and cantilever tip are present.</p>	<ul style="list-style-type: none"> • If the cantilever tip is not visible, or it is not attached to the scan head, it is likely broken and a new cantilever tip must be installed. • In such an instance, first alert the NanoLab supervisor, then refer to the Mounting Probe Cantilever Tip section in the Operation Manual for instructions on how to install a new tip. <ul style="list-style-type: none"> ○ Click on “Help” at the bottom of the Video window. ○ Double-click on “Nanosurf Easyscan 2 AFM Operating Instructions”. 	 <p>Cantilever Tip</p> 
<p>Raise the lid of the black plastic AFM isolation box and gently set in open position.</p>		

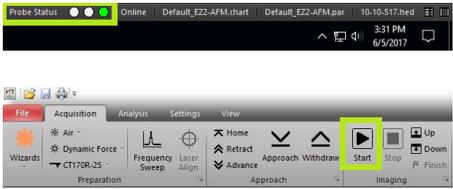
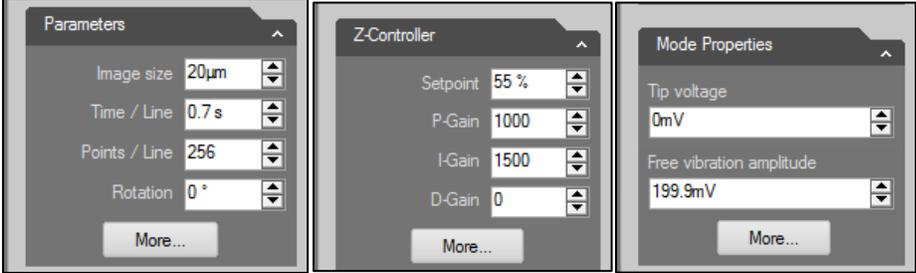
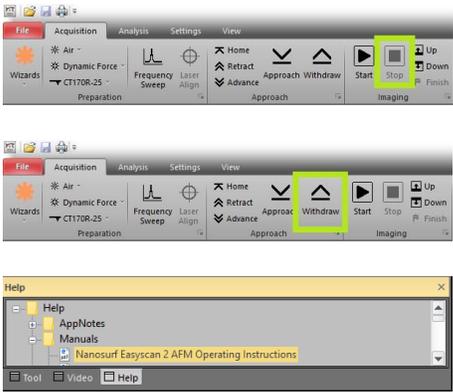
¹ Adapted from Graupp, P. & Wrona, R. (2006) The TWI Workbook: Essential Skills for Supervisors. New York, NY. Productivity Press.

<p>If uncertain whether loaded sample assembly will have sufficient clearance under cantilever tip, raise the AFM scan head.</p>	<ul style="list-style-type: none"> • It is better to have too much clearance than risk damaging the cantilever tip. • For initial clearance check, place loaded sample holder on stage <i>near</i> scan head, but do not slide under tip. • Gently turn the three leveling screws on the AFM scan head <i>clockwise</i> (to raise) until the cantilever tip at the bottom of the scan head will be <i>at least 2mm higher</i> than the height of the loaded sample holder. <ul style="list-style-type: none"> ○ Clockwise turns <i>raise</i> scan head; ○ Counterclockwise turns <i>lower</i> scan head. 	 <p>Ensures that the cantilever tip does not contact any part of the loaded sample holder when it will be slid underneath.</p>
<p>After sufficient clearance has been verified:</p> <ul style="list-style-type: none"> • Slide the loaded AFM sample holder underneath the AFM scan head. • Align the sample's area of interest below the AFM cantilever tip. 	<ul style="list-style-type: none"> • CAUTION! Perform this step <i>very carefully and slowly</i>. • Verify sample is directly below cantilever tip by viewing from at least two horizontal positions, 90° apart (i.e., triangulate point of view). 	 <p>Careless/quick loading could cause impact between loaded AFM sample holder and cantilever tip and damage the cantilever tip and/or AFM scan head.</p>
<p><u>Lower</u> and <u>level</u> the AFM scan head.</p>	<p>While performing the following key points, frequently check the clearance between cantilever tip and sample surface to avoid damaging the tip.</p> <p>With the round/circular bubble level placed on top of the AFM scan head:</p> <ul style="list-style-type: none"> • Turn the three leveling screws on the AFM scan head until the cantilever tip is <i>no less than 1mm above</i> the sample area of interest (higher than 1mm is OK). <ul style="list-style-type: none"> ○ For efficiency, simultaneously turn two screws one turn in same direction; then turn the third screw one turn in same direction. ○ Clockwise turns <i>raise</i> scan head; ○ Counterclockwise turns <i>lower</i> scan head. ○ Ensure bubble level is centered within the black circle after each set of turns. 	 

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<ul style="list-style-type: none"> • Remove bubble level from scan head. • Gently close the lid of the black plastic AFM isolation box. • Remove disposable gloves. 		
Software Operation for Sample Characterization		
<p>Set the AFM cantilever tip parameters.</p>	<ul style="list-style-type: none"> • First verify the cantilever tip type and model. • NOTE: As of May 2017, the following tip characteristics apply: <ul style="list-style-type: none"> ○ In the <i>Preparation</i> group of the <i>Acquisition</i> tab, select “Air” medium, “Dynamic Force” mode, and “CT170R-25” tip. 	
<p>“Advance” the AFM scan head and cantilever tip.</p>	<ul style="list-style-type: none"> • CAUTION: do not “crash” cantilever tip and scan head into loaded sample holder. • While observing the Video Side View window on the software, LEFT CLICK+HOLD the “Advance” button to bring the cantilever tip within a virtual distance of no less than 1cm of the sample surface (greater than 1cm is OK). <ul style="list-style-type: none"> ○ “Virtual distance” refers to the apparent distance between the cantilever tip and its shadow in the Video Side View window. (True distance is actually <<1mm) 	
<p>Perform a frequency sweep.</p>	<ul style="list-style-type: none"> • CLICK the “Frequency Sweep” button. • In the Vibration Frequency Sweep Tuning pop up window: <ul style="list-style-type: none"> ○ CLICK the “Find Vibration Frequency” button; ○ CLICK+DRAG the small black square on the vertical dashed line under the Amplitude... curve to center it at the peak; • CLICK “OK”. 	
<p>“Approach” the AFM scan head and cantilever tip to the sample surface.</p>	<ul style="list-style-type: none"> • While observing the Video Side View window, LEFT CLICK the “Approach” button to automatically bring the cantilever tip to the sample surface.  <ul style="list-style-type: none"> • Click “OK” when “Approach done.” window pops up. 	<p>“Approach” automates the final descent of the cantilever tip to the sample surface to eliminate the potential for the Operator to damage or break the cantilever tip and/or scan head.</p> 

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<p>Start measurement.</p>	<p>Once Operator sees the Probe Status is GREEN (located at bottom of software window):</p> <ul style="list-style-type: none"> • CLICK on the “Start” icon/button. • DO NOT BUMP ANYTHING IN CONTACT WITH THE AFM ISOLATION BOX. 	 <p>AFM is EXTREMELY sensitive to all types of waves, especially vibrational.</p>
<p>If necessary (i.e., if image quality is poor), adjust operating parameters from the default settings.</p>	<ul style="list-style-type: none"> • In the left column of boxes with adjustable data fields on the software, change values according to sample characteristics, cantilever tip manufacturer’s specifications, and image quality. • The following are merely one of myriad suggested values: 	 <ul style="list-style-type: none"> • Values in the “Parameters” and “Z-Controller” boxes can be adjusted while scanning a sample. • Values in the “Mode Properties” box should only be adjusted when the scan has been stopped.
<p>If necessary (i.e., if image quality is poor, or if Probe Status light turns Red or Orange):</p> <ul style="list-style-type: none"> • Stop measurement, • Withdraw cantilever tip, and • Repeat previous four steps. 	<ul style="list-style-type: none"> • CLICK on the “Stop” icon/button. • CLICK on the “Withdraw” icon/button. • Repeat previous four steps until image quality meets Operator’s needs (i.e., go back to “Perform a frequency sweep”). • If needed, refer to manufacturer’s official Operating Instructions for more detailed information on Frequency Sweep and Operating Parameters. <ul style="list-style-type: none"> ○ Click on “Help” at the bottom of the Video Side View Window. ○ Double-click on “Nanosurf Easyscan 2 AFM Operating Instructions”. 	
<p>Proceed to “Atomic Force Microscope (AFM) Shutdown” Work Instructions (See Number: <u>07</u>)</p>		

¹ Adapted from Graupp, P. & Wrona, R. (2006) The TWI Workbook: Essential Skills for Supervisors. New York, NY. Productivity Press.