Magnetostriction Setup

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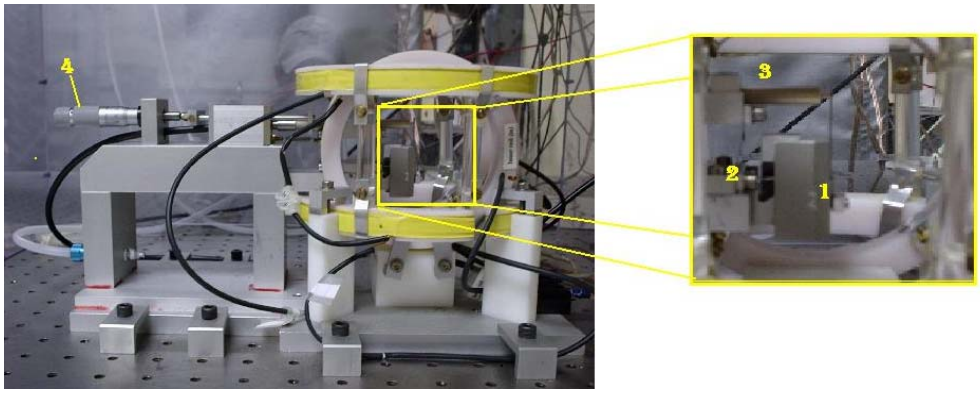

Figure A

Calibration Procedure:

1. TURN ON EQUIPMENT - Turn on all equipment (computer interface, power supply, oscilloscope, audio amplifier, MTI Photonic Sensor)

2. PLACE SAMPLE - Make sure the optical fiber is withdrawn far enough to avoid making contact with the sample. Place sample in the sample holder (1 in Fig. A) in the center of the Helmholtz coils. It will slide between the sample holder and the copper spring, and be held in place by the spring. The sample holder can be adjusted vertically to change effective length of the sample by increasing the clamping distance. The scale located on the side of the sample holder can be adjusted from 2 to 8 and determines the clamping distance. Generally, measurements should be made at the maximum sample length (8 on the scale) to increase the sensitivity of the measurement by maximizing the magnitude of the deflection.

3. SET CALIBRATION MODE - The MTI Photonic Sensor is now ready to be calibrated. This should be done by first switching the sensor to calibration mode with the MODE switch on the far right side of the sensor.

4. MAXIMIZE VOLTAGE SIGNAL - Use the micrometer (4 in Fig. A) to move the optical fiber closer to the sample. The display on the sensor shows a voltage. The optical fiber should be slowly moved toward the sample until this voltage reaches a maximum value, usually ~1.5V. When approaching the sample, BE CAREFUL, DO NOT LET THE OPTICAL FIBER COME IN CONTACT WITH THE SAMPLE. This can severely damage the sensor.

When the voltage is at a maximum, the sensor is at the optical peak. Figure B illustrates the output of the optical probe versus probe gap.

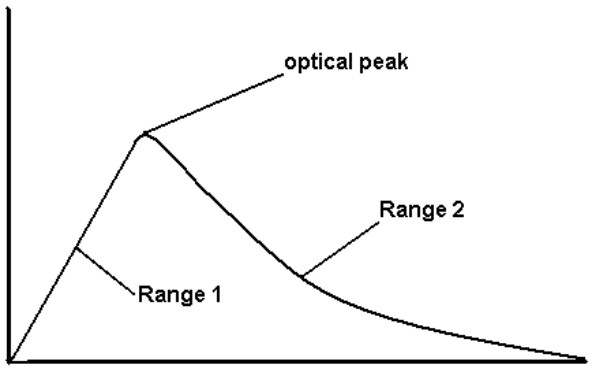

Figure B

5. SET CALIBRATION POINT - When the probe is at the optical peak, press the SET CAL button on the sensor, and wait for the system to set the point.

6. SWITCH TO DISPLACEMENT MODE - Set the MODE switch to displacement. This will change the display from volts to microns. The readout will probably be ~33 microns. Remember, this is the value when the probe is at the peak. Measurements should be made in the "Range 1" portion, or on the front slope of the curve (Fig. B).

7. MOVE PROBE INTO RANGE - The probe can be moved into the "Range 1" position by slowly moving it closer to the sample until the display zeros out (+/- .05 is close enough). Again, be careful the probe does not touch the sample.

8. SWITCH TO HIGH GAIN - Once the probe is in range, close the hood covering the setup and switch the gain to "HIGH."

9. ADJUST OFFSET - Adjust the offset knob and again zero the display (+/-.009 is acceptable). Look to the external oscilloscope and adjust it to display the DC Coupling, which will show the deflection of the sample during the measurement. The base line should be as close to zero as possible to ensure that the measurement will stay in the readable range.

10. ALLOW SYSTEM TO STABILIZE – Because the micrometers are oil-driven, the display will drift until the system settles. The system usually takes 15 to 30

minutes to settle enough to begin taking measurements. It may be necessary to readjust the offset after the system stabilizes.

Measurement Procedure:

When a magnetic thin film is exposed to an external magnetic field, the atoms or molecules of the film tend to align parallel to the direction of the applied field. If the magnitude of the field is high enough, the atoms or molecules will elongate, or stretch, thus producing a stress on the substrate, causing it to slightly "bend." If the applied field rotates in a plane parallel to the alignment of the sample, the sample will "vibrate", due to the varying direction of the stress. The photonic sensor in the apparatus essentially measures the maximum deflection of the sample during this vibration.

1. OPEN MAGNETOSTRICTION PROGRAM – After the calibration, the system is now ready to begin measuring. Start by opening the Direct Magnetostriction LabView program on the PC.

2. ADJUST PARAMETERS – Adjust the parameters of the program, i.e. the substrate thickness, film thickness, desired maximum field strength, integration time, number of data points, etc. The clamping distance can be read from the scale on the side of the sample holder. For quick measurements, 20 data points and an integration time of 1 sec. are sufficient. Be sure to enter a sample name that will identify the sample and measurement for later analysis.

3. RUN MEASUREMENT – During the course of the measurement, the strength of the magnetic field is displayed, along with the deflection and calculated magnetostriction above the plot area in the program. The oscilloscope on the power supply also represents the relative magnitude of the field, and the external oscilloscope displays the relative magnitude of the deflection, during intervals when the magnetic field is being applied.

4. ANALYZE DATA – When the measurement is complete, a graph will appear in the plot area of the magnetostriction program. This is a plot of the maximum deflection (in micrometers) as a function of applied magnetic field (Oe). The data file is also saved in a designated folder, and can be imported into Excel for further analysis.