Atomic Force Microscope

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Section 1
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I. ABSTRACT

II. INTRODUCTION

III. THEORETICAL BACKGROUND

IV. EXPERIMENTAL DESIGN AND PROCEDURE

The equipment used in this laboratory was:

- Atomic Force Microscope
- SICONA tip
- ACLA tip
- Easyscan Controller
- Easyscan 2 software
- 10μm AFM calibration grid
- CD sample
- Diffraction grating sample

As both the calibration grid and the CD sample have fairly uniform patterns the SICONA tip and a static force operating mode were used. The SICONA tip was first mounted into the cantilever on the Atomic Force Microscope (AFM). The microscope was then mounted on the stage and adjusted to allow enough space sample holder to be placed underneath it. This was done by adjusting the positioning screws, with the aid of a spirit level to ensure that the device remained level.

After the first sample, a 10 μm calibration grid, was placed under the microscope we initialised the microscope and set the operating mode on the Easyscan software to a SICONA tip and static force mode. From the positioning window it is possible to see through two cameras in the microscope, both of which show a different view of the tip and sample. Using the top view we positioned the sample so that the tip rested above an area that was free from contaminants and scratches. Then, using the side view, we used the 'Advance' function of the software to slowly lower the tip so that it was very close to the sample. The 'Approach' function was then used so that the software would adjust the height of the tip to find 'contact' with the sample. After the approach was completed the scanning of the sample area started.

The settings used for the calibration grid were:

- Area: 50μm
- Time/line: 1s
- Points/line: 256
- Rotation: 0°

It was important to invoke the 'Finish' command in the software so that the AFM would stop scanning after the desired region had been scanned. Had we not ensured that this was checked the AFM would continue scanning, losing the data from the first iteration.

The diffraction grid showed a number of evenly spaced raised squares. Using the cross section tool we selected a line that passed through the centres of a number of the squares. We then clicked on 'Cut Out Line' button which displayed a line graph showing the height against the displacement for the cross section that we defined.

We used the zoom function so that we could accurately measure the size of a single square on the grid. We set the function to zoom in on an area that encompassed only one of the squares from the grid and changed the 'Time/line' parameter to 0.5s to speed up the scanning process. Once initiated the AFM started rescanning the area. Once we were presented with the image of a single square we used the measure tool to take measurements of its height and width.

For our second sample, the CD fragment, the procedure and set up was essentially the same as before. We did however change the scanning parameters to:

- Area: 15μm
- Time/line: 0.7s
- Points/line: 256
- Rotation: 0°

From the scan of the CD fragment we measured the size of the pits that could be seen on the surface as well as the track spacing.
Our third sample, the gold coated diffraction grating, had a surface that was far more irregular than the previous two. Because of this a dynamic operating mode is preferable. ACLA tips are used when operating in dynamic mode, so we removed the SICONA tip and replaced it with an ACLA. We then changed the operating mode to accept an ACLA tip and use a dynamic force.

We started the scanning process in the same manner as before and set the scan parameters to:

- Area: 15μm
- Time/line: 0.7s
- Points/line: 256
- Rotation: 0°

We then found a reasonably uniform area of the grating and zoomed in on it, in the same manner as before, in order to try to identify the gold specs.

V. ANALYSIS

The output from the scan of the 10μm calibration grid is shown in figure 1.

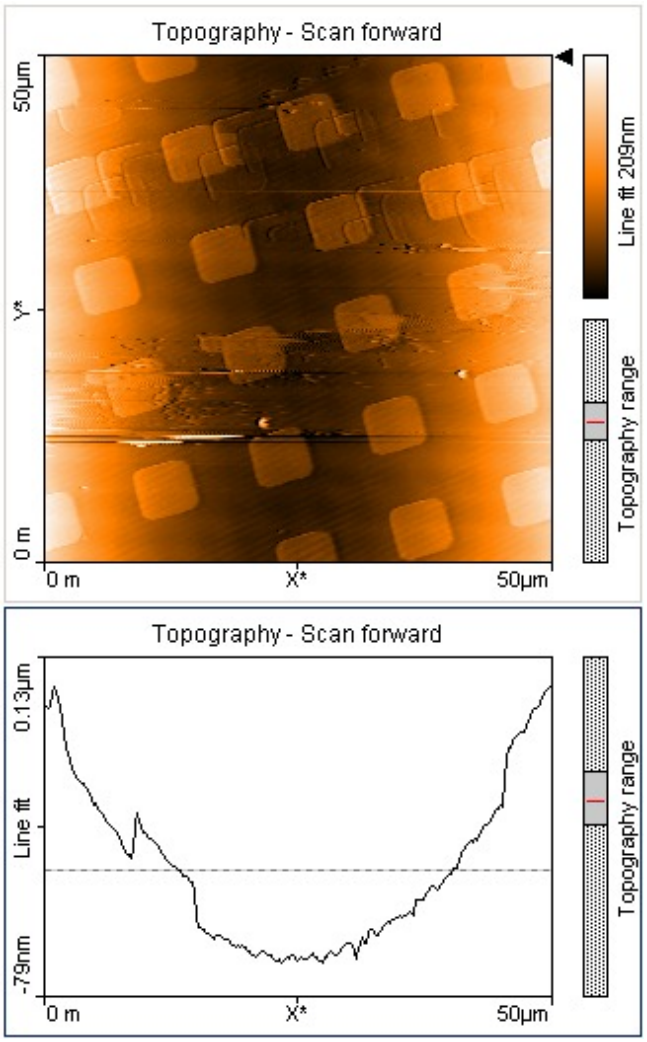

FIG. 1: Colour map and line graph representing 10μ AFM calibration grid

From the scan we can see a number of rows of uniformly spaced raised squares. The graph seems to show that the sample curves up towards the edges. This is likely an anomalous scan as the probability of us taking our image directly positioned over the lowest peak of a valley is low. The cross sectional line graph is given in 2.

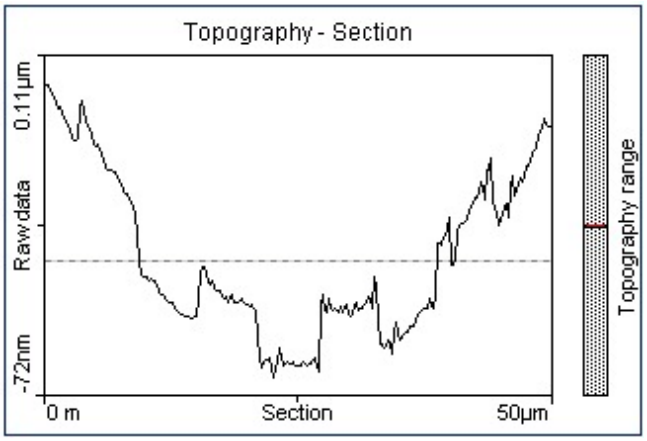

FIG. 2: Cross sectional area line graph showing height against position

This graph shows the curvature that was mentioned and is consistent with inferences taken from the colour map of the same sample.

We zoomed in on one of the squares in order to measure the size of each square. The colour map of the magnified area is given in figure 3. Using the measure tool provided in the software we were able to determine the height width and area of the square, the results are:

$$\text{Length} = 5.181 \pm 0.0005\ \mu\text{m}$$
$$\text{Width} = 5.921 \pm 0.0005\ \mu\text{m}$$
$$\text{Area} = 30.68 \pm 0.0007\ \mu m^2$$

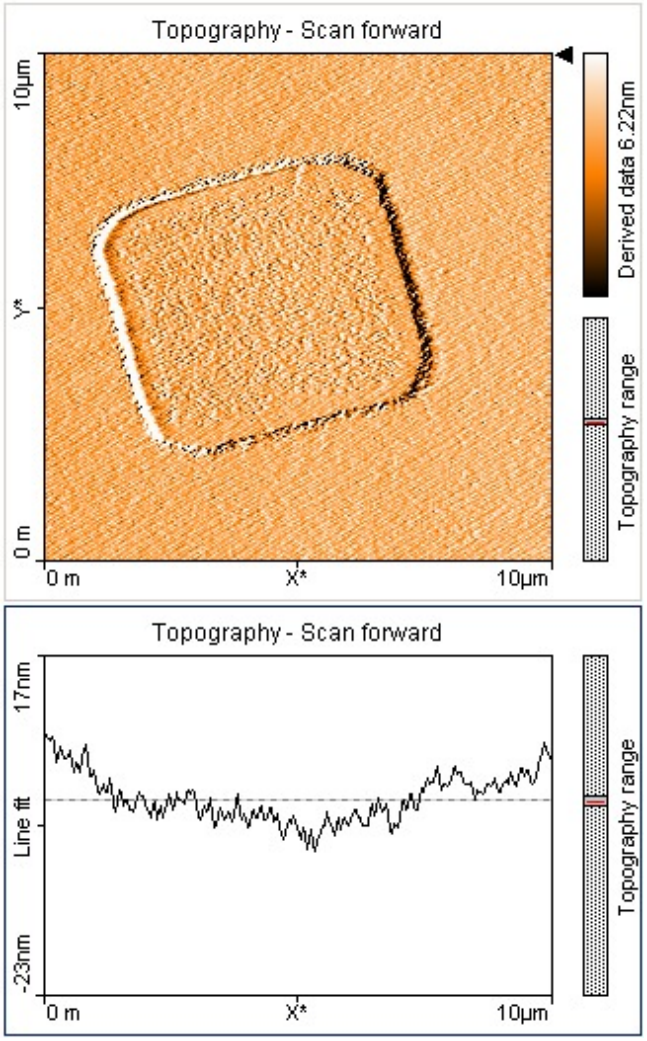

FIG. 3: Colour map and line graph showing a single square from the surface of the calibration grid

The colour map for the CD fragment is shown in figure 4. It can be seen that there are a number of indents that are arranged in tracks on the surface of the CD. Using the measure tool we measured the length of a number of the indents and the spacing of the tracks. The results from these measurements are:

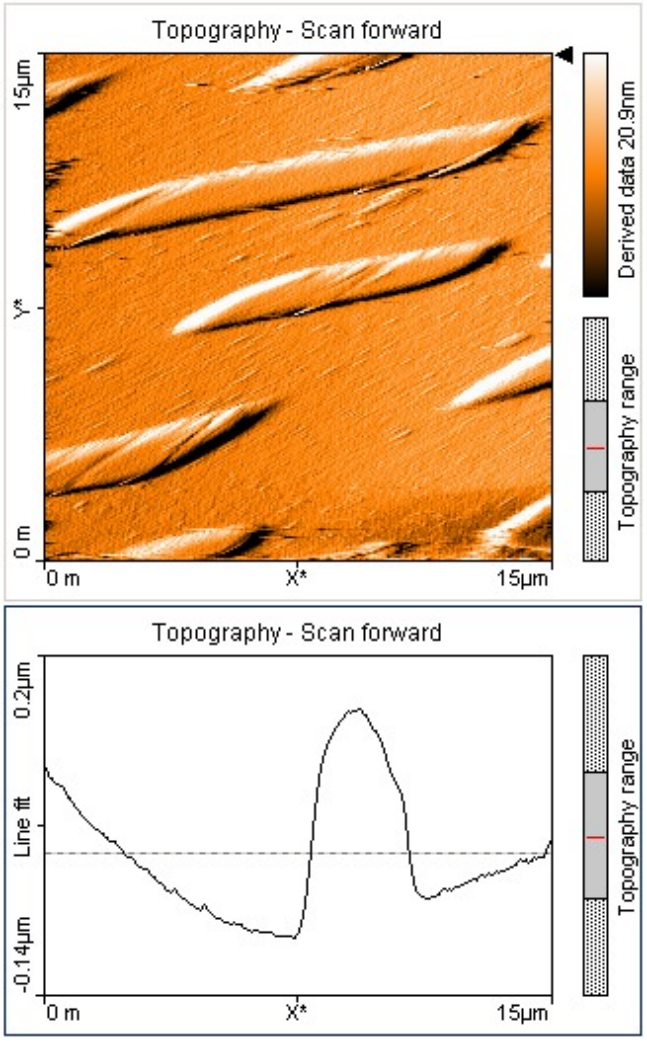

FIG. 4: Colour map and line graph showing the scan of a CD fragment

Our final scan is shown in figure 5. This is of a gold plated diffraction grating and ideally would show a uniform distribution of parallel lines that make up the grating. Our reading were skewed with every attempt at scanning the sample. Figure 5 is the closest to true form that we were able to extract from the program.

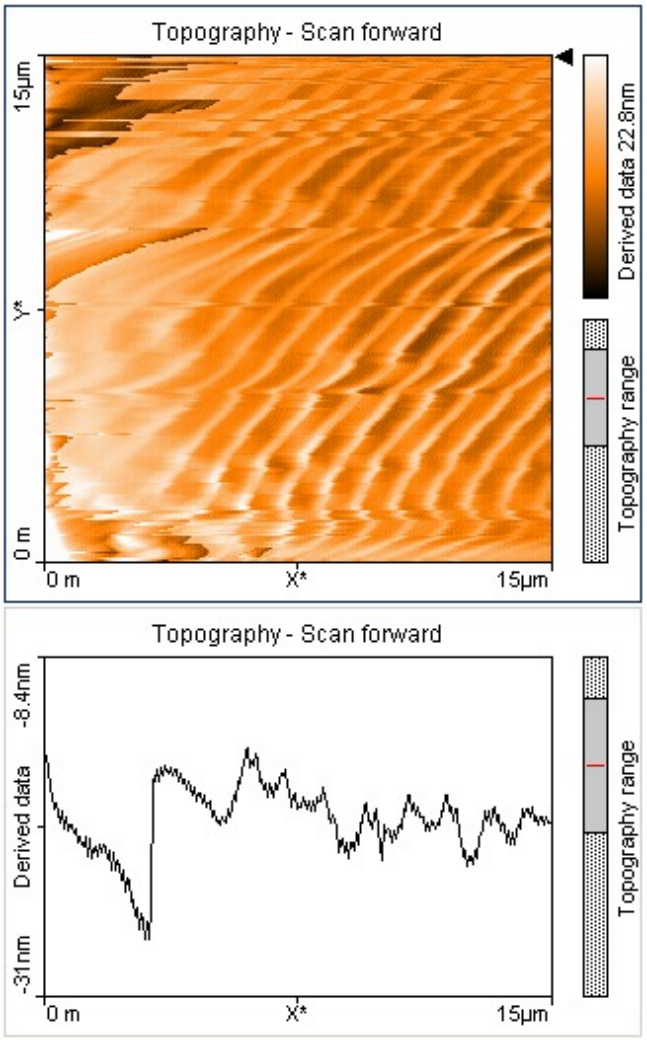

FIG. 5: Output from scan of gold plated diffraction grating.

Our final step of the experiment was to scan a small area of the grating that had a reasonably uniform distribution in order to identify 'pillow shaped' gold pieces on the surface. The output from this scan is given in figure 6. We were not able to identify any gold pieces in this scan, and suspect that there was some form of experimental error in the reading of this scan that is to blame.

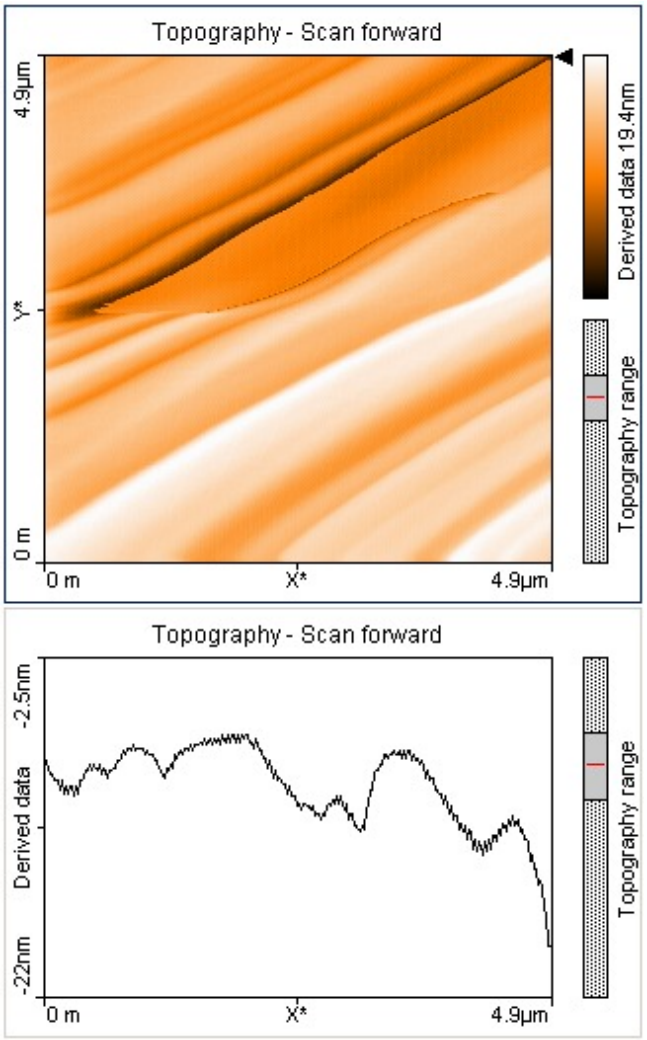

FIG. 6: Output for a small area of the gold plated diffraction grating

VI. CONCLUSION

Appendices

APPENDIX A: RAW DATA