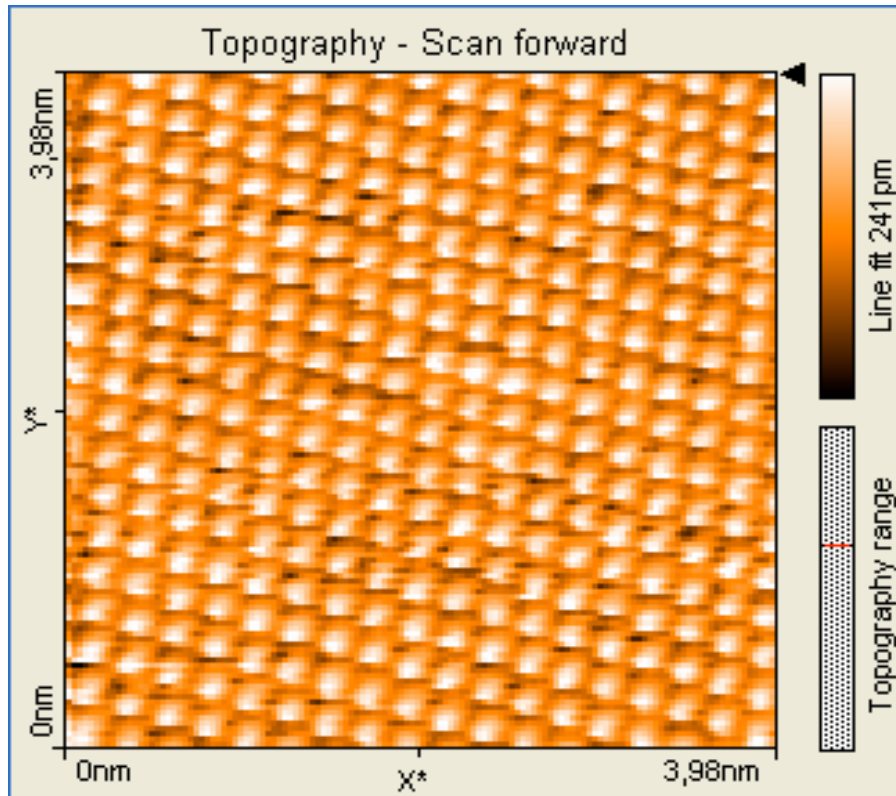


UNDERGRADUATE AWARD FINAL REPORT



PROJECT: STM STUDIES OF GRAPHITE SURFACE

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Nanostructures on Graphite

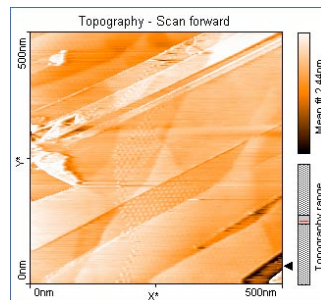
Abstract

This report summarizes progress towards Scanning Tunneling Microscope (STM) studies of nanoparticles on graphite surface. Our original aim was to look at nanoparticles of various shapes and sizes, especially gold nanoparticles several hundred atoms large bound to bacteriophages (few nanometers in diameter) and organized on the surface of graphite--viral nanowires. We have, however, been bogged down by several equipment problems which have hampered progress in that direction. Our main accomplishments so far in this project have been limited to observations of the surface of graphite using our STM (Nanosurf EasyScan2 shown in the left-most photo below) and obtaining a practical experience with handling nano-materials. The project will be continued in the next semester during which we will make systematic observations of self-assembly of nanoparticles on the surface of freshly cleaved graphite.

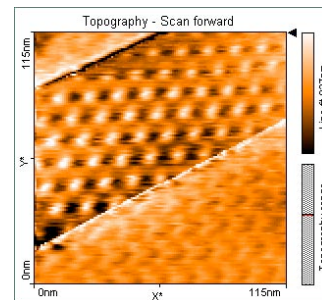
Current Progress

We worked with the commercially available high quality cleaved graphite (HOPG) and used Pt/Ir wires (of diameter 0.25 mm) to form sharp (10–100 nm wide) tips by mechanically cleaving the wire as well as by electrochemically etching it and polishing the resulting sharp tip. Some of the resultant images from the best tips are shown below at two different magnifications. Comparing these to the image on the front page of this report two things can be easily discerned: (i) the center image shows bands of varying colors which is a way of visualizing different heights (corrugation) on a graphite surface; (ii) the single layers of graphite on different steps overlap resulting in an interference (Moire) pattern images by the STM. This is seen both in the center image (where hexagonally arranged dots are seen across multiple steps) and in the close-up image on the right. The right-most image shows hexagonal patterns with lattice spacing more than ten times the lattice spacing of actual graphite lattice (front page image).

These experiments convinced us of the adequate resolution power of Scanning Tunneling Microscopy under ambient conditions. We therefore proceeded to studying how gold nanoparticles (of average size 5 nm) arrange themselves on such a freshly cleaved graphite surface. This proved to be much more challenging than we had anticipated. In our attempts to view graphite samples with gold nanoparticles we managed to contaminate the STM. The ensuing repairs took all of the remaining semester. As a result we could not make any useful observations of gold nanoparticles on graphite.



Steps and overhangs on graphite surface



Superstructure on graphite (Moire pattern)

Financial Report

\$420 Gold Nanoparticles; \$200 HOPG samples; \$75 Pt/Ir Wire

Conclusion and Future Plans

The plan for the next semester is to first image gold nanoparticles on graphite surface and try to see how the unevenness of the cleaved graphite surface (that lead to the observation of Moire' patterns) affects their distribution. Then we will use the bacteriophages bound to gold nanoparticles and observe their self-assembly on graphite surfaces.