MatSci 571
First (of 2) Homework Assignment - Spring 2009
Due April 7, 2009
All Answers must be **typed** - no hand writing!

1) You are trying to create a vacuum in a chamber 10 cm on a side. What pressure and what type(s) of pump will you need if the residual gasses are in the:

a) Knudsen flow regime

b) Ballistic flow regime

c) Have a mean free path 1000 times greater than the dimensions of the container.

2) Answer the following using 200 words **or less** (eqns not counted as words) for each part.

a) Discuss the difference between the viscous flow and molecular flow regimes in vacuum technology.

b) Why must thin film physical deposition occur in the molecular flow regime?

c) What are the implications (relative to viscous and molecular flow) of using an oil fluid mechanical pump to create a vacuum?

3) Given the following types of pressure gauges, what would be the appropriate range of their application? (Be careful with the last two. Technology has improved in recent years and their low pressure range has been extended)

a) McCleod gauge

b) Thermocouple vacuum gauge

c) Pirani gauge

d) Capacitance manomiter

e) Cold cathode gauge

f) Bayard-Alpert gauge

4) Give examples and include surface images (from the litterature), for cases other than shown in class, of films exhibiting:

a) Volmer-Weber growth

b) Frank- van der Merwe growth

c) Stranski-Krastanov growth

5) Look up an interesting (to you) type of self-assembled film. Write a short (200-300 words) essay about it. Include information on how its made, how it has been characterized, and why anyone cared. Be sure to give proper citations.

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Second (of 2) Homework Assignment - Spring 2009
Due April 20 (to Lori Bruce) 2009
All Answers must be **typed** - no hand writing

1) Write a short (2 typed pages and 2-3 figures) report on **ONE** of the following techniques and its application to Materials Science. Please try to find an example related to your interests.

a) Atomic force microscopy
b) STM based spectroscopy
c) Magnetic force microscopy
d) Electron beam deposition
e) Ion beam assisted deposition
f) RF sputtering
g) Scanning tunneling microscopy

2) For the case of tunneling through a relatively thick barrier (a few angstroms or more), the tunneling current is given (approximately), by:

$I = AVexp[-1.03\phi^{1/2}d]$, where A is a constant, V is the bias voltage, ϕ is the work function in eV, and d is the barrier thickness in Angstroms. Consider a STM having a tungsten metal double tip, with one tip being only 2 atomic diameters longer than the other. If the feedback loop is set to maintain the current at 0.5 nA, and the work function is 4 eV, what is the % of current carried by the shorter tip? What does this tell you about the required tip shape for atomic resolution on flat surfaces?

Suppose the same situation as above, and that the two tips are separated in space (x,y) by 25 nm. Predict the image you would obtain of a sharp step 3 nm tall.

3) List the essential elements of a scanning probe microscope and clearly state the importance of each to the overall function of the microscope.