6 Future Research Interest

A successful research program requires both a set of good ideas and the flexibility to adapt to opportunities for collaboration. The development of scanning point probes has opened many new opportunities for research. This class of instruments includes scanning tunneling microscopes (STM), scanning force microscopes (SFM), scanning magnetic probes and scanning optical probes. These instruments have been used to explore topics as diverse as semiconductor surface physics to mapping the surface of living cells.

I am interested in both the development of new instruments and their application to problems in physics and surface science. There are a number of problems in condensed matter physics and materials science which I would like to explore. I would also like to develop collaborations with other scientist both locally and externally. Industrial collaborations can lead to sources of external funding as well. My experience is designing STMs will allow me to develop specialized instruments to meet the needs of others.

To be a little more specific, our work in testing the mechanical properties of nanotubes can be expanded with new MEMS devices which would fit inside an AFM. Further, measurement of electrical properties of nanotubes by STM, EFM, and conducting AFM is a potentially rich area for new research that is still largely unexplored. The nano-sized world is now expanding into 2-dimensional materials such as graphene and h-BN, topological insulators, and layered materials. A second area with great potential is the use of dip pen nano-lithography (DPN). While the lithography method itself is new and a subject of further research, this technique has the potential to be used as a guide for the further assembly of other nano-devices. For example, attachment points for functionalized nano-tubes can be precisely created in specific locations via DPN.

Setup of these instruments requires no special facilities beyond normal lab space and a very quiet floor. Cost is quite modest by modern standards. Probably the best approach to startup, is to purchase a small commercial instrument which can be used to generate results and publications quickly. Building on this, the first instrument can be added to, and new devices and experiments developed over time. The simplicity of the basic concept and the wide range of problems that can be investigated with a scanning probe instrument make it a good field for undergraduate as well as graduate student work.

In addition to surface physics instrumentation, I have gained considerable experience in synthesis of 2 dimensional materials. Graphene, h-Bn, and so on. One of the short falls in many group's efforts in this field is that they do not understand how critical purity is in the process. Using my experience in surface physics to design better reactor systems and eliminate defects can be a very productive research area. I believe that the performance of devices made from these materials can be greatly improved by careful control of not just reactor conditions, but the elimination of contaminates in the reactants.

To summarize, I wish to continue to work in the area of scanning probes, surface science and 2-D materials. But to be flexible and far ranging in their application to a broad range of problems.