Extended Abstract with Poster

Nanotechnology Concepts through Lab Modules for K-12 and Community College Students

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Abstract

The advancement of technology has led researchers to explore further the real life problems in more detail. Interestingly, the solutions to these problems demand expertise in more than one discipline. This has necessitated various skills to come together. In engineering, a new discipline has emerged which we call *nanotechnology*. Nanotechnology is purely interdisciplinary in its nature. This is the need of the hour that we amend our conventional ways of dealing with the contemporary problems and start thinking beyond the conventional ways. Nanotechnology is one such example where we have extended the boundaries of various engineering disciplines. This is really important that the next generations of students are familiar with this revolutionary field and are motivated to pursue their education in this area. In this paper we present lab modules which can help familiarizing K-12 and community college level students with basics of nanotechnology without the need of sophisticated lab facilities.

Introduction

Nanotechnology has become cynosure for the scientific world during the last few years. The reason is that this emerging technology has had an impact on almost every field of science and engineering. The further advancements in this field are going to have far-reaching effects on almost all aspects of our daily life. A well-prepared and highly motivated work force is the key

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need for every nation to lead in emerging fields. Unfortunately there is a lack of awareness in youth about this technology because currently there are no courses or introductory modules of nanotechnology offered at the K-12 and community college levels [1]. Interest among students for various fields of science start at very early stages. If students don't get know-how of nanotechnology early on, it will be very difficult for them to develop interest and get motivation to do some work in this new field [2]. This is the need of the hour that suitable methods should be developed like lab modules etc. to familiarize K-12 and community college level students with this emerging field. This paper presents some basic modules that have been developed in a way that the basic concepts of nanotechnology like top-down fabrication and bottom-up self-assembly are delivered without the need for cleanroom and sophisticated equipment. The simple lab-modules also depict concepts of lithography, pattern transfer and etching to deliver the essence of this technology with hands-on exercises. The students can better understand the concepts and can apply these to understand the phenomenon like hydrophobicity, hydrophilicity and self-assembly etc.

Approach and Methodology

We have designed lab modules to familiarize K-12 and college level students with basic concepts of solid-state fabrication and properties at nanoscale. The simple processes like photolithography, pattern transfer, etching, etc. are depicted using silly putty, printed ink (laser print-outs, newspaper), compact discs, DVDs, etc. The special properties of materials at nanoscale like self-assembly, quantum confinement, etc. are explained with simple hands-on activities. Once the 'big ideas' are explained through the important critical concepts, the students are challenged to come up applications where this knowledge can be useful. It is then easy to explain examples of clothes that don't get dirty, car wash soap that wouldn't let dust settle on the body, etc. These activities provide evidence that students have understood the concepts. A possible next step would be to use the learning from the workshop to define more rigorous benchmarks for the students willing to take advanced workshops in various departments involved.

Fabrication process is the key element of nanotechnology and currently only graduate students get hands-on-experience with these processes. These concepts should be made available, through simple lab exercises, to K-12 and college level students as well so that the interest for this emerging field evolve at an early stage and once these students reach at the graduate level they have enough taste and expertise in this area that they can play an active role and can be more productive in their work. Previously only a top-down approach was used for

solid-state fabrication but there were some major limitations with that technique which made grounds for bottom-up fabrication process.

First, students are introduced to the fabrication process through the instructional manuals. This instructional manual is developed in a way to make it easy and understandable for K-12 students. Once students get some taste of these processes and concepts like photolithography, etching, self-assembly and deposition etc. they are involved in simple exercises so that they can get some hands-on experience of these basic concepts.

Figure 1. Module Design

Conclusion

To cope up with the fast moving technological developments and to make sure that we have well-prepared manpower to actively participate in emerging fields like nanotechnology, it is a very timely effort to familiarize and motivate youth with the basics of this field. The approach is very simple and doesn't require any sophisticated lab equipment.

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References

1. C. K. Lee, T. T. Wu, P. L. Liu, and S. Hsu, "Establishing a K–12 Nanotechnology Program for Teacher Professional Development ", *IEEE Transactions on Education*, vol. 49, no. 1, pp. 141-146, 2006.
2. T. T. Wu, and C. K. Lee, "Taiwan: Ministry of Education and NTU implementing Taiwan Nanotechnology K–12 Education Program," *Asia–Pac. Nanotechnol. Forum News J.*, vol. 2, no. 1, pp. 17–19, 2003.

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