To Design a Nanotechnology Based Power Saving Device

Prof Preeti Lodaya, Prof Sushma Ganesh Kore, Prof Shailaja Mohite

Electronics& Telecommunication, KCCEEMSR Thane,India

Abstract—

The tool which is used for designing Nanoelectronic devices, like Computer Aided Design (CAD), has the major limitation ,that is to cope up with the ever-increasing design complexity of nanoscale integration. Due to ultra-small size of the devices, 3D effects have become dominant. In order to achieve a better understanding of simulated and fabricated device characteristics, 3D process/device simulation is essential.. .In my research work I will focus on,designing of nanotechnology based devices for preparation and characterization for sustainable energy.

Keywords-energy conversion, dye sensitized solar cell, signal integrity, technology CAD(TCAD).

I INTRODUCTION

To achieve pre-designed and affordablesynthesization, and characterization of new functional nanomaterialsis achallenge. Also a

design for nanotechnology based devices ,on large-scale with controllable sizes, shapes, and/or structures,*for new and improved methods of energy conversion, without compromising our environment* is a problem to be solved Nanotechnology has played an extremely important role in the synthesis, and characterization of various new and novel energy materials and catalysts for processing fuels from fossil fuel resources such as coal, petroleum, and natural gas. Today, fossil fuels still account for 90% of the world's energy consumption, and their use is expected to peak around the year 2050. . The widespread use of fossil fuels is plagued with problems such as the generation of increasingly

serious environmental problems, the related climate changes we are witnessing,The use of fossil fuel based technologies is probably one of the main causes of the continuous increase in the pollution and the fact that the long-term availabity of crude oil is limited. Therefore, it is necessary to develop a suite of sustainable energy sources and energy-storage materials. Renewable sources must have higher contribution on the energetic matrix in providing more energy available for the humanity in a short period, having low environmental impact.

However, consensus on Computer-aided design(CAD) for scalable nonmanufacturing has yet to be achieved, and many challenges remain in nonmanufacturing. Particularly for hybrid processes, it is more important to integrate and manage individual processes from the software perspective. Given this background, it is important to review the characteristics of recent nonmanufacturing processes and identify the essential requirements of CAD systems for scalable. However, nanomanufacturing despite the continued effort and advances, the available technologies are not yet fully applicable to manufacturing at the nanoscale to realize scalable, high-yield processes with high degrees of freedom. Achieving mass manufacturability and high flexibility has been a major issue in manufacturing generally, and is much more challenging at the nanoscale. Indeed, because we are reaching the fundamental limits of individual fabrication processes, it is important to seek synergies among them for 'scalable nanomanufacturing' with mass manufacturability and high flexibility

II LITERATURE SURVEY

Nanostructuring have been highlighted over several decades in both science and engineering fields. In addition to continuous efforts in fabrication techniques, investigations in scalable nanomanufacturing have been pursued to achieve reduced feature size, fewer constraints in terms of materials and dimensional complexity, as well as improved process throughput. In this study, based on recent nanoscale fabrication processes, characteristics and key requirements for computer-aided design and manufacturing (CAD) systems for scalable nanomanufacturing were investigated. Requirements include a process knowledge database, standardized processing, active communication, adaptive interpolation, a consistent coordinate system, and management of peripheral devices. For scalable nanomanufacturing, it is important to consider the flexibility and expandability of each process, because hybrid and bridging processes represent effective ways to expand process capabilities. As an example, we describe a novel CAD system for hybrid three-dimensional (3D) printing at the nanoscale. This novel hybrid process was developed by bridging aerodynamically focused nanoparticle printing, focused ion beam milling, micromachining, and spin-coating processes. The system developed can print a full 3D structure using various inorganic materials, with a minimum process scale of 50 nm. The most obvious difference versus CAD at 'conventional' scales is that our system was developed based on a network to promote communication between users and process operators. With the network-based system, it is also possible to narrow the gap among different processes/resources. We anticipate that this approach can contribute to the development of CAD for scalable nanomanufacturing and a wide range of hybrid processes.

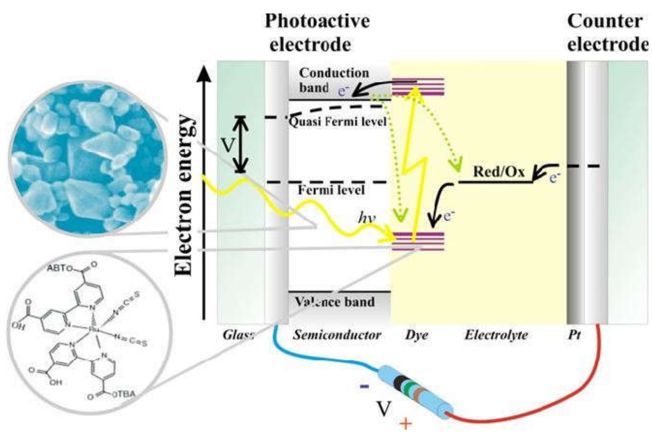

Figure.2 Schematic of a dye-sensitized solar cell, the performance of which critically depends on nanoscale components. Light absorption occurs in a dye, which is anchored to a nanoporous semiconductor layer .

Dye-sensitized solar cells (DSCs) invented by Michael Grätzel became a very popular alternative to silicon based solar cells because of their great potential to convert solar energy into electric energy at low cost . This cell can be made from cheap materials such as inorganic and organic dyes which do not need to be highly pure as is required for siliconwafer.

The dye-sensitized (Gratzel) solar cell (Fig. 2) is perhaps the earliest solar cell directly utilizing nanoscale components for its performance . Here, light absorption takes place predominantly in dye molecules anchored to the surface of nanoparticles of a wide bandgap semiconductor, usually TiO_2.

III Scope and statement of the problem

Several software packages have been developed to assist in semiconductor processes. Commercial software, such as INTELLICAD and MEMSCAP, can be used to design and simulate micro device fabrication; these software packages are capable of constructing 3D structures based on the processes involved.

However, existing CAD systems are not fully applicable to scalable Nano manufacturing. Flexibility and the expandability of individual processes have not been considered, because some systems were developed for specific processes. Furthermore, CAD for scalable nanomanufacturing requires not only nanoscale processing capabilities but also compensation for nanoscale effects. A system should be able to assist and simulate the micro-/nanoscale processes involved. For effective and precise fabrication in scalable nanomanufacturing, it is important to establish a consensus for a novel CAD system.

IV.METHODOLOGY

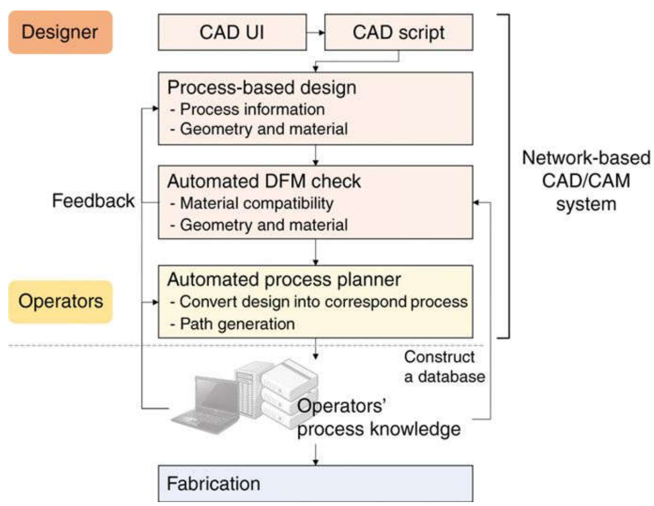

Figure 3 : a schematic diagram of the CAD system developed.

Designers can design a part based on the fabrication process, and the DFM rules check the manufacturability automatically at the design stage. A process plan can be generated both automatically and by process operators. Also, both designers and operators can check the automatically generated process plan; this can be revised with respect to the operators' proficiency.

As mentioned so far, characteristics of the CAD system developed are coupled with the suggested requirements, that is, process knowledge database—DFM rules warning system. However, peripheral devices are not currently managed by the CAD system. Each process has its own peripherals, and the CAD system provides CAM files per each individual process. For more efficient bridging, peripheral information will be recorded and managed by the CAD system. Peripherals may include several modules, simply from vacuum pumps to manipulation/measurement modules in the FIB chamber. These peripheral modules can contribute not only to the improvement of individual process efficiency, but also to creation of novel processes, that is, scribing or assembly. Peripheral information will be shared both with designers and operators.

Nevertheless, the current developed system has a process knowledge database in DFM rule form, standardized processing, active communication, and a consistent coordinate system. The system provides an open platform for hybrid 3D printing between designers and operators. Both design and process plans can be modified and visualized easily. In addition, DFM rules will be kept updated with more experimental data. New processes may be updated with correspondent CAM systems. We anticipate this approach can contribute to the development of a CAD system for scalable nanomanufacturing.

V.RESULT

As mentioned before, the process can be applied in mass manufacturing by fabricating a mold or tool within a mass manufacturing process. Once the shape has been settled, FIB milling can be substituted, and throughput can be significantly improved to be applied to the mass manufacturing. One of the current issue is filling of nanoparticles to the desired pocket. Sometimes structures have large pores due to unstable variations of the printing process. Another issue is the deformation control of polymer layers during a mold or tool fabrication at micro-/nanoscale. Precise adaptive control with more process knowledge would be required in order to overcome these problems. Nevertheless, by combining it with other mass manufacturing techniques at the nanoscale, the process can be used to fabricate 3D freeform structures with improved throughput. From this perspective, the network-based CAD system can contribute to efficient bridging of different disciplines and communication with each other. Though mentioned processes have various environments (that is, different vacuum conditions), nanoscale 3D printing process can be constructed in a much more beneficial way than one hardware configuration. As mentioned so far, bridging and hybrid are considered as key requirements in scalable nanomanufacturing due to the fundamental limits of individual process physics. A network-based CAD system can provide a platform of bridging with the suggested key requirements. The structure and CAD system can thus advance scalable nanomanufacturing research efforts.

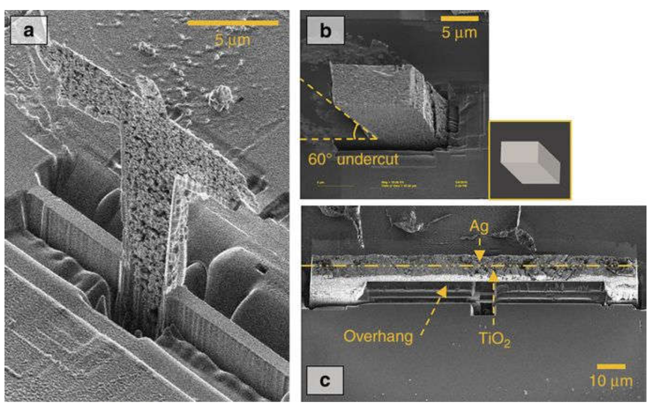

Figure 5a shows a statue with nanoscale features and various types of undercut. Figure 5bshows a tilted pillar with an undercut of 60°, and Figure 5c shows a bimaterial cantilever.

The items in Figures 5a and b were made of silver, while that in Figure 5c was made of silver and titanium oxide. These fabricated examples show 3D printing at the nanoscale and hybrid characteristics.

As an example, we describe a novel CAD system for hybrid 3D printing at the nanoscale. The system was constructed on the network-based OpenJSCAD platform for active communication among designers and process operators. Characteristics of the developed CAD system and suggested key requirements were compared. This network-based 3D printing system with key requirements can contribute to the paradigm shift from DFM to

MFD. Design and manufacturing plans can be controlled flexibly and adjusted. 3D printed features at the nanoscale were shown in the fabricated samples. Because scalable nanomanufacturing is one of the most advanced manufacturing techniques, characteristics of CAD systems can also be applied to the novel concept of hybrid processes. Considering that bridging different processes may provide breakthroughs for a future manufacturing paradigm, it is also suitable for cloud-based design and manufacturing.

Through this research, the concept of CAD for scalable nanomanufacturing has been discussed and developed. Scalable nanomanufacturing will enable variable engineering applications with the assistance of a novel CAD system. We anticipate that this approach will contribute to the development of CAD for scalable nanomanufacturing, as well as a wide range of hybrid processes.

Sustainable energy production, transformation and use are very much needed to maintain the readily and cheap access to energy to the growing and increasingly demanding world population while minimizing the impact on the environment. The novel multifunctional materials produced from the broad and multidisciplinary field that is nowadays called nanotechnology are critical to overcome some of the technological limitations of the various alternatives to the non-renewable energies. Novel multifunctional materials produced trough utilization of nanotechnology offer great improvements in all domains of total energy system, such as transportation and storage of energy. To predict where and how nanotechnology will have the largest impact is not possible. On the short term basis it will probably have more visible influence on existing energy system through introduction of better and more energy efficient materials, on fuel conversion schemes etc.. In farther future nanotechnology will most likely play a major role in the development of truly sustainable solutions like advanced PV systems. For sustainable energy production nanotechnology is one of the fastest growing research fields today.

VI. Conclusion

In this paper,nanoscale fabrication techniques were briefly reviewed, and key requirements for a CAD/CAM system for scalable nano manufacturing were listed. Among various fabrication techniques, bridging different processes is considered to be a breakthrough in going beyond existing fundamental limits for each process alone. CAD/CAM systems for scalable nanomanufacturing should have the following key characteristics: process knowledge database, standardized processing, active communication, adaptive interpolation, a consistent coordinate system, and management of peripheral devices. These characteristics and requirements are expected to contribute to the development of a novel manufacturing paradigm.

As an example, we describe a novel CAD/CAM system for hybrid 3D printing at the nanoscale. The system was constructed on the network-based Open CAD platform for active communication among designers and process operators. Characteristics of the developed CAD/CAM system and suggested key requirements were compared. This network-based 3D printing system with key requirements can contribute to the paradigm shift from DFM to MFD. Design and manufacturing plans can be controlled flexibly and adjusted. 3D printed features at the nanoscale were shown in the fabricated samples. Because scalable nanomanufacturing is one of the most advanced manufacturing techniques, characteristics of CAD/CAM systems can also be applied to the novel concept of hybrid processes. Considering that bridging different processes may provide breakthroughs for a future manufacturing paradigm, it is also suitable for cloud-based design and manufacturing.

Through this research, the concept of CAD/CAM for scalable nanomanufacturing has been discussed and developed. Scalable nanomanufacturing will enable variable engineering applications with the assistance of a novel CAD/CAM system. We anticipate that this approach will contribute to the development of CAD/CAM for scalable nanomanufacturing , as well as a wide range of hybrid processes.

Sustainable energy production, transformation and use are very much needed to maintain the readily and cheap access to energy to the growing and increasingly demanding world population while minimizing the impact on the environment. The novel multifunctional materials produced from the broad and multidisciplinary field that is nowadays called nanotechnology are critical to overcome some of the technological limitations of the various alternatives to the non-renewable energies. Novel multifunctional materials produced trough utilization of nanotechnology offer great improvements in all domains of total energy system, such as transportation and storage of energy. To predict where and how nanotechnology will have the largest impact is not possible. On the short term basis it will probably have more visible influence on existing energy system through introduction of better and more energy efficient materials, on fuel conversion schemes etc.. In farther future nanotechnology will most likely play a major role in the development of truly sustainable solutions like advanced PV systems. For sustainable energy production nanotechnology is one of the fastest growing research fields today.

Nanomaterials serve as energy carriers, absorbents, media for energy transfer, catalysts, converters, and energy pools or vessels for reactions. In all of these applications, the core technology to be developed is the preparation of novel nanomaterials with controllable sizes, shapes, and/or structures. Conventional methods, such as doping, impregnation, and ion exchange, will continue to be used, but there is great opportunity to learn from and try to mimic the nanomaterials and nanomachinery in nature. Many properties of living systems could potentially be harnessed, and methods based on non equilibrium characteristics will have interesting applications in the future.

References

[1] Serrano, Elena, Guillermo Rus, and Javier Garcia-Martinez."Nanotechnology for sustainable energy." Renewable and Sustainable Energy Reviews 13, no. 9 (2009): 2373-2384.

[2]. HERDMAN, RC. "Studies of the Environmental Costs of Electricity."US Congress, Office of Technology Assessment–OTA,, Washington, DC,1994.

[3]. Badawy, Waheed A. "A review on solar cells from Si-single crystals to porous materials and quantum dots." Journal of advanced research(2013).

[4]. Zäch, Michael, Carl Hägglund, DinkoChakarov, and BengtKasemo. "Nanoscience and nanotechnology for advanced energy systems." Current Opinion in Solid State and Materials Science 10, no. 3 (2006):132-143.

[5]. Tsakalakos, L. ― Application of micro and nanotechnology in photovoltaics.‖ Comprehensive Renewable Energy, (2012), 515-531.

[6]. Babu, VeluruJagadeesh, SeshaVempati, Subramanian Sundarrajan, MerumSireesha, and Seeram Ramakrishna. "Effective nanostructred morphologies for efficient hybrid solar cells."*Solar Energy* 106 (2014): 1-22.

[7]. Honsberg, Christiana B., Allen M. Barnett, and Douglas Kirkpatrick. "Nanostructured solar cells for high efficiency photovoltaics." In Photovoltaic Energy Conversion, Conference Record of the 2006 IEEE 4th World Conference on, vol. 2, pp. 2565-2568. IEEE,2006.

[8]. Wright, Matthew, and Ashraf Uddin. "Organic—inorganic hybrid solar cells: A comparative review." Solar energy materials and solar cells 107 (2012): 87-111.

[9]. Deshpande, M., Seyezhai, R. ―Review ofhybrid solar cells based on CdSe and TiO_2 materials‖ International Journal of Innovative Research in Computer and Communication Engineering, vol 2 issue 3,(2013).

[10]. European Commission, (2013). Nanotechnology: Research and Innovation the invisible giant tackling Europe's future challenges [Online]. Available FTP: https://ec.europa.eu/research/industrial_technologies/pdf/nanotechnology_en.pdf

[11]. Solar Cells: Nanotechnology Applications under Development [Online], Available FTP: http://www.understandingnano.com/solarcells.html

[12]. Dursun, Bahtiyar, and CihanGokcol. "Impacts of the renewable energy law on the developments of wind energy in Turkey." Renewable and Sustainable Energy Reviews 40 (2014): 318-325.

[13]. Tejeda, Jenny, and Susan Ferreira. "Applying Systems Thinking to Analyze Wind Energy Sustainability."Procedia Computer Science 28 (2014): 213-220.

[14]. Li, Ying, and Jian Lu. "Lightweight structure design for wind energy by integrating nanostructured materials." Materials & Design 57 (2014): 689-696.

[15]. Ng, Kai-Wern, Wei-Haur Lam, and SaravananPichiah. "A review on potential applications of carbon nanotubes in marine current turbines."RenewableandSustainableEnergyReviews28(2013):331-339.

[16]. The Application of Nanotechnology to Energy Production [Online], Available FTP: http://www.understandingnano.com/nanotechnology-energy.html

[17]. Luther, W. (2008), Application of nanotechnologies in the energy sector [Online], Available FTP: http://www.hessen-nanotech.de/mm/NanoEnergy_web.pdf

[18]. Centre for Nano Science and Engineering, IISc, Research - Nanomaterials(August, 2011) [Online], Available FTP: http://www.cense.iisc.ernet.in/research/nanomaterials.htm

[19]. The PrashantKamat Laboratories, University of Notre Dame, Solar Cells (2012) [Online], Available FTP: http://www3.nd.edu/~kamatlab/research_solarCells.html

[20]. Thematic Unit of Excellence, Indian Institute of Technology, Nanoscience and Nanotechnology in Nanofabrication : Top-down, Bottom-up and Beyond (2012) [Online], Available FTP: http://www.iitk.ac.in/nanoscience/projects.html

[21]. V D Swami And Company Limited, Rooftop solar power for home office in Chennai (2012) [Online], Available FTP: http://vdswami.com/vdsolar/index.php/solyndra-pv-system

[22]. Centre for Nanosciences, Amrita University, Nanosolar (2014)[Online], Available FTP: http://www.amrita.edu/center/nanosciences/nanosolar [23].Department ofElectronics and Information technology, Ministry of communication and IT, Government of India, Projects initiated under Nanotechnology Development Programme (2014) [Online], Available FTP: http://deity.gov.in/content/nanotechnology-initiative-division-projects

[24]. CSIR, National Physical Laboratory, Thermoelectrics Bulk, Nano and Thin Films (2014) [Online], Available FTP: http://www.nplindia.org/thermoelectrics-bulk-nano-and-thin-films

[25]. Vachaparambil, Kurian J., Eric Aby Philips, Karan Issar, VaidehiParab, DivyaBahadur, and Sat Gosh. "Optimal Siting Considerations for Proposed and Extant Wind Farms in India." Energy Procedia 52 (2014): 48-58.