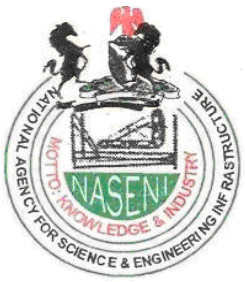
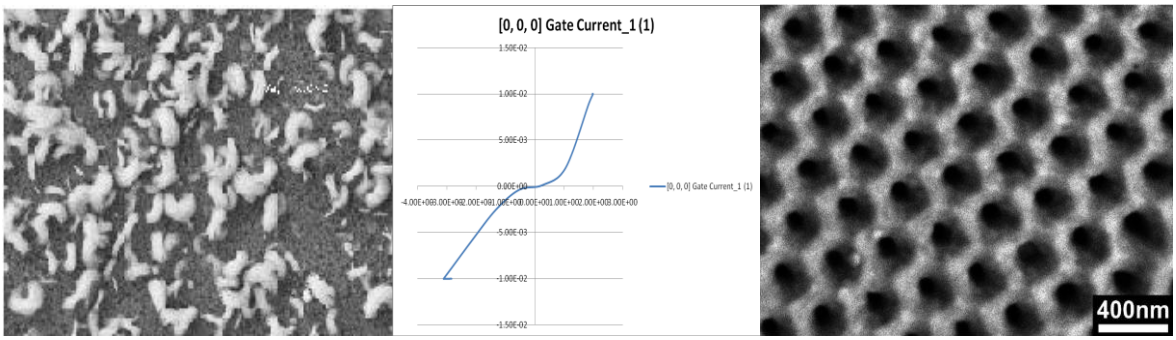
NASENI



NATIONAL AGENCY FOR SCIENCE & ENGINEERING INFRASTRUCTURE

Progress report on

Nanotechnology Programs - Workshops and Grant Scheme



Participants

Prof. O. O. Adewoye - Director-General
Dr. A. Y. Fasasi - Nanotechnology Consultant and Project Coordinator

- Dr. Fabian Ezema, University of Nigeria Nsukka (UNN),
- Miss Ogbu Precious, National Agency for Science & Engineering Infrastructure
- Miss Ezenwafor Theresa, Engineering Materials Development Institute, (EMDI), Akure.
- Prof. E. O. B. Ajayi of Physics Department, Obafemi Awolowo University, Ile-Ife.
- Dr A.R. Adetunji of Materials Science & Engineering Department, Obafemi Awolowo University, Ile-Ife.
- Mrs Okorie N, Engineering Materials Development Institute, (EMDI), Akure.
- Engr. Oyelami A, Engineering Materials Development Institute, (EMDI), Akure.
- Dr. Dare E., Federal University of Agriculture, Abeokuta (UNAAB).
- Engr. Ogundare O., Engineering Materials Development Institute (EMDI), Akure.
  - Mr. Attah-Daniel B. E., Engineering Materials Development Institute (EMDI), Akure.
- Mr. Ebisike K of of Engineering Materials Development Institute (EMDI), Akure.
- Mr. Imoisili P of Engineering Materials Development Institute (EMDI), Akure.

PREFACE

NASENI IN BRIEF - THE MANDATE OF THE AGENCY

The National Agency for Science and Engineering Infrastructure (NASENI) was established in 1992 by decree no. 33 to make available in the Nigerian market, the primary and intermediate capital products required for machine and equipment design, fabrication and mass production, in order to provide the enabling environment for a sustainable industrialization of the country. To implement this mandate, NASENI was to establish infrastructure development Centres in the various fields of Science and Engineering. The primary target is to empower small and medium scale industries, through impartation of technologies, engineering principles and practices for the production of equipment that will meet international standards as well as flourish local capital goods industry.

The Mandate of NASENI is specifically in the area of capital goods research, production, and reverse engineering with respect to the following six broad areas:

- Engineering materials (notably irons, steels, non-ferrous metal and alloys, plastics, glass, ceramics, polymer electronics and nanotechnology); Industrial and analytic chemical materials including industrial gases;
- Scientific equipment and components for education, research and industry; including measuring instruments, electronic components, communication equipment and computers;
- Engineering accessories (mechanical, hydraulic, pneumatic, electrical and electronic);
- Engineering Design of components parts, plants and processes.
- Power equipment (generation, transmission, distribution, prime movers); and
- Mechanical Engineering tools (power tools, hand tools, cutting tools and machine tools).

NASENI DEVELOPMENT INSTITUTES

In pursuant of his mandate the Agency operates through Development Centres. So far, there are eight Development Centres established. They are:

(i) Science Equipment Development Institute (SEDI), Enugu

- The development and production of scientific equipment and their production systems, and the transfer of these to private sector satellite industries;

(ii) Science Equipment Development Institute (SEDI), Minna

- The development and production of scientific equipment and their production systems, and the transfer of these private sector satellite industries;

(iii) Electronic Development Institute (ELDI), Awka (formerly, Centre for Adaptation of Technology (CAT))

- The development and production of electronic materials and assemblies, and their production systems, and the transfer of these to private sector satellite industries;

(iv) Hydraulic Equipment Development Institute (HEDI), Kano

- The development and production of hydraulic and pneumatic machinery, materials , and their production systems and transfer of these to private sector satellite industries;

(v) Engineering Materials Development Institute (EMDI), Akure

- The development and production of engineering materials and their production systems, and the transfer of these to private sector satellite industries;

(vi) National Engineering Design Development Institute (NEDDI), Nnewi (formerly, National Engineering Design Development Centre (NEDDEC))

- The development of engineering design capacity and its dissemination to Small and Medium Enterprises (SME's) in order to standardize Nigerian made products and make them globally acceptable.

(vii) Power Equipment and Electrical Machines Development Institute (PEEMADI), Okene (formerly, Power Equipment and Electrical Machinery Development Centre (PEEMADEC)).

- The development and maintenance of power and electrical equipment and their production systems and the transfer of these to private sector satellite industries.

(viii) Prototyping Engineering Development Institute (PEDI), Ilesa

- The development of engineering prototypes and their production systems and the transfer of these to private sector satellite industries.

(ix) Advanced Manufacturing Technology Programme (AMTP), Taraba

Nanotechnology Heritage in Nigeria

HISTORICAL BACKGROUND OF NANOTECHNOLOGY RESEARCH ACTIVITIES IN NIGERIA

The concept of nanosciences was initiated in 1994 culminating in the award of a PhD supervised by Prof. O. O. Adewoye to Dr. M. O. Adeoye of Materials Science & Engineering Department of Obafemi Awolowo University in 1998.

Visit to Princeton Materials Institute (Princeton University) in 2002 by Prof. O. O. Adewoye

- NASENI – USAMI-Africa MRS Collaboration was aimed at exposing researchers as well as post-graduate students to state-of-the-art equipment for carrying out their studies in diverse fields of Materials Science and Engineering.
- It also included student exchange.
- Under this programme, more than 10 senior as well as junior researchers have undergone research collaboration and training at Princeton University, NJ, USA, through NASENI/USAMI/Africa MRS .

- More than 13 publications in top journals over a period of 2-3 years.

In addition, all USAMI fellows were sponsored to the 4th International Conference of the African Materials Research Society held in Tanzania in 2007.

USAMI Grantees from Nigeria

Prof. O. O. Adewoye	(2002)
Dr. G. M. Oparinde	(2004)
Dr. B. Babatope	(2004)
Dr. W. Siyanbola	(2004)
Prof. G. A. Osinkolu	(2005)
Dr. A. Y. Fasasi	(2006)
Dr. M. O. Adeoye	(2007)
Prof. B. I. Imasogie	(2004 & 2007
Dr. M. A. Eleruja	(2008)

Publications Emanating From Nanotechnology and Nanosciences Research

1. Z. Zong, J. Lou, V.D. Giessen, E.A. Widjaja, O.O. Adewoye, F. Hammad, A.A. Elmustafa and W.O. Soboyejo (2005) Scale Effects in Nano and Microhardness of FCC single crystals. (Materials Science and Engineering).
2. E. O. Dare,* G. A. Olatuniji, D. S. Ogunniyi. Octasilsesquioxane as Hybrid Nanocomposite Platforms. II. Synthesis, Characterization and Ceramic Properties of some Alkyl-functionalized Silsesquioxanes*. Polish J. Chem., 79, 101–107 (2005).*
3. E. O. Dare,* Ling-Kang Liu and James Peng, Modified Procedure for improved Synthesis of Octameric Silsesquioxanes Nanocomposites via Sol gel process in the presence of Amberlite ion-exchange resins, *Dalton Trans*. *3668 - 3671 (2006).*
4. M. O. Adeoye, and O. O. Adewoye (2006), Nanoindentation Study of Tourmaline Ounal of Minerals and Materials, Characterization and Engineering Vol. 5, No 1, pp 63 – 72
5. Babatope Babaniyi, Zong Zong, Thomas Woodson, Onobu Akogwu, Suberr Chi, Rahbar Nima and Wole Soboyejo. AFM Measurements of Adhesion between Au and PEDOT:PSS. *Proceedings of Nigerian Materials Congress (NIMACON-2006)* held at the Merit House, Maitama District, Abuja, Nov. 15-18, 2006, p. (Nigeria)
6. G.M. Oyatogun, W. O. Soboyejo, A.A. Afonja, B.I. Imasogie and M.O. Adeoye, (2006) Effects of Increasing Nano-Scale Coating Thickness Of Titanium On Silicon Biocompatibility, Proceedings of the Nigerian Materials Congress (NIMACON- 2006), Center for Energy Research and Training, Zaria, Nigeria, November 15-18, 2006
7. Adeoye M. O., Theriault C. and Soboyejo W. O. (2007) Cell Detachment from Glass and Polydimethylsiloxane Surfaces. Paper presented at the 4th International Conference of The African Materials Society (Africa-MRS) held at College of Engineering and Technology (CoET), University of Dar es Salaam, Tanzania. 10th – 14th December 2007.
8. Yang, Y.; Imasogie, B. I; Allameh, S. M.; Boyce, B.; Lian, K.; Lou, J. and Soboyejo, W. O. (2007) Mechanisms of Fatigue of LIGA Ni MEMS Thin Films. *Materials Science and Engineering A*; Vol. 444, 1-2, 39-50.
9. Yang, Y.; Yao, N. Imasogie, B. I. and Soboyejo, W. O. (2007) Nanoscale and submicron fatigue crack growth in Nickel microbeams. *Acta Materialia*, Vol. 55, 4305–4315.
10. A. Y. Fasasi, R. Bucher, B. Ngom, U. Buttner, M. Maaza, C. Theron, E. G. Rohwer, "Structural and Optical Properties of Annealed W-doped $BaTiO_3$ Thin Films Prepared by Pulsed Laser Deposition", "J. Phys.: Condens Matter", Vol. 19, pp. 466214-(2007).
11. A. Y. Fasasi, M. Maaza, E. G. Rohwer, D. Knoessen, Ch. Theron, A. Leitch, U. Buttner, *"Effect of Zn-doping on the Structural and Optical Properties of $BaTiO_3$ Thin Films Grown By Pulsed Laser Deposition",* "Thin Solid Films", Vol. 516. No. 8, pp. 6226 – 6232, (2007),

12. A.Y. Fasasi, M. Maaza, Ch. Theron, A. Leitch, A.K. Chaudhary, U. Buttner, P. Neethling. "Non-Linear Absorption and Second Harmonics Imaging of Zn-$BaTiO_3$ Thin Films Prepared By Laser Ablation". "Thin Solid Films", Vol. 516. No. 8, pp. 6233 – 6239, (2007),
13. Babatope B., Adewoye, O. O. and Soboyejo, W.O.; Organic Electronics Technology Development: Prospects and Challenges for a Developing Economy (*Ife Journal of Science*, 2008) (Nigeria)
14. Babatope B., Zong Z., and Soboyejo W. O.; Interfaces in Organic Electronic Devices. (*Ife ournal of Science*, 2008) (Nigeria).
15. A. Y. Fasasi, S. Mwenifumbo, N. Rahbar, J. Chen, M. Li, A. C. Beye, C. B. Arnold, and W. O. Soboyejo, "Nanosecond UV Laser Processed Microgrooves on Ti6Al4V for Biomedical Applications: "Mat. Sci. & Eng. C, Vol. 29, No. 1, pp. 5-13, (2009).
16. B. D. Ngom, T. Mpahane, N. Manyala, U. Buttner, J. B. Kana, A. Y. Fasasi, M. Maaza, A. C. Beye, Structural and Optical properties of Nano-structured Tungsten-doped ZnO Thin Films grown by Pulsed Laser Deposition, "Appl. Surf. Sci.", Vol. 255, pp. 4153 – 4158, (2009).
17. B. D. Ngom, O. Sakho, N. Manyala, J. B. Kana, N. Mlungisi, L. Guerbous, A. Y. Fasasi, M. Maaza[3], A. C. Beye, Structural, morphological and photoluminescence properties of W-doped ZnO nanostructures, "Appl. Surf. Sci.", Vol.255, pp. 7314-7318, (2009).
18. A.Y. Fasasi, B.D. Ngom, J.B. Kana-Kana, R. Bucher, M. Maaza, C. Theron, U. Buttner, Synthesis and Characterisation of Gd-doped $BaTiO_3$ Thin Films Prepared by Laser Ablation for Optoelectronic Applications. Accepted for publication in "J. Phys. & Chem. Solids", 2009.
19. Dare E.O., Ayinde W. and Alayande S. (2009) Nanoporous Silica from Rice hull ash using surfactant template sol-gel process. J. Mater. Soc. (Accepted).
20. Fu G., Milburn C., Mwenifumbo S., Cao Y., Oparinde G. M., Adeoye M. O., Therialt C., Beye A.C. and Soboyejo W.O. (2009) Shear Assay Measurements of Cell Adhesion on Biomaterials Surfaces. *Journal of Materials Science and Engineering* C 29(4), 1293-1301.
21. Milburn C., Cao Y., Oparinde G. M., Adeoye M. O., Beye A. and Soboyejo W. O. (2009) Investigation of Effects of Argenine-Glycine-Aspartate (RGD) and Nano-Scale Titanium Coatings on Cell Spreading and Adhesion. *Journal of Materials Science and Engineering C* 29(1), 306-314.
22. Cao Y., Chen J., Adeoye M. O. and Soboyejo W. O. (2009) Investigation of the Spreading and Adhesion of Human Osteosarcoma Cells on Smooth and Microgrooved Polydimethylsiloxane Surfaces. *Journal of Materials Science and Engineering C* 29(1), 119-125.

NIGERIA NANOTECHNOLOGY INITIATIVE WORKSHOP (NNI) (2006)

1.0 Introduction

In recent years, nanotechnology has emerged as the next frontier for the exploration of science and the development of new technologies. The current projections suggest that a multi-billion dollar global market will emerge over the next 1-2 decades. It is expected that nanoscience and nanotechnology will impact such diverse fields as medicine, agriculture, energy, water purification, and even infrastructure.

Nigeria is yet to be identified on the nanotechnology consumer produce map, however, the National Agency for Science and Engineering Infrastructure (NASENI), a Federal Government Parastatal of the Ministry of Science and Technology (FMS&T) has taken an initiative to put Nigeria on the world map at the shortest possible time.

1.1 The Starting Point

This initiative spurred the National Agency for Science and Engineering Infrastructure (NASENI) to organise on June 8 and 9, 2006 at the Transcorp Hilton Hotel in Abuja, a two-day workshop on Nigerian Nanotechnology Initiative (NNI). The objective of the workshop was to develop an integrated Nigerian effort that will enable Nigeria to become a major player in the areas of nanotechnology within five years. The workshop was attended by technocrats, experts and stakeholders in the science and engineering fields. Papers were presented in various areas of nanotechnology.

The workshop was organized in order to identify groups interested in these areas, enlist the interest of all experts and stakeholders in this forum and fashion out a roadmap for the country's active involvement in the pursuit and utilization of knowledge in Nanotechnology.

1.2 Presidential Endorsement

It is also noteworthy that the former President of the Federal Republic of Nigeria, Chief Olusegun Obasanjo, GCFR, has in the Science and Technology retreat held on the 17th August 2006, approved Nanotechnology as the fourth leg of the national development policy on Science and Technology. The other three are Biotechnology, Information and Communication Technology and Space Technology. In line with the President's statement, the Honourable Minister of Science and Technology accorded NASENI the approval for the establishment of a National Nanotechnology Centre.

1.3 Benefit for Nigerians

Within the context of Nigeria, nanotechnology has the potential to stimulate a renaissance in Nigerian science, while providing innovative solutions to problems in a number of areas. These include: new and affordable approaches to nanomedicine, nano-engineered seeds, plants and animals for improved agriculture, nano-scale thin films for solar cells and light emitting devices for alternative energy and nanostructured porous materials for water

purification. Nanoscience and nanotechnology will also provide an exciting new frontier that could promote interdisciplinary collaboration between researchers in universities and research institutions across the different parts of Nigeria.

1.4 Niche Areas

The NNI collaboration is expected to create an enabling environment where the group can engage in a complete program that ranges from new ideas in nanoscience to engineering systems and markets. Four major areas relevant to country's needs in particular and global needs in general have been targeted namely;

- Nano-medicine (for disease detection and treatment)
- Nano-energy (solar cells and light emitting diodes)
- Nano-biology (in agriculture for production of drought resistant seeds, food preservation and genomics)
- Nanoporous materials (production of nano-porous filters for water purification and bio-oxidants)

The NNI will involve interdisciplinary collaboration between scientists, engineers, doctors and entrepreneurs with the potential to engage in a complete program that ranges from new ideas in nanoscience to engineering systems and markets.

In the diaspora, the project will include contributions from Nigerians who are actively involved in nano-research and development activities.

1.5 Progress so Far

In continuation of the Nigerian Nanotechnology Initiatives, three (3) programmes were earmarked for execution within the 2008 - 2011 fiscal years. These programmes are;

- ❖ NASENI's Nanotechnology Workshops and Trainings
- ❖ NASENI's Nanotechnology Research Grant Scheme and
- ❖ NASENI's Nanotechnology Visiting Researcher's Scheme

These 3 programmes are now elaborated below.

NASENI'S NANOTECHNOLOGY PROGRAMS - IMPLEMENTATION OF THE NNI'S DECISIONS

2.0 NASENI's Nanotechnology Workshops and Trainings

Under this program, two (2) workshops and trainings have been organised namely;

- Nanoparticle production workshop and Training useful in the areas of medicine held on the **14th and 15th of August, 2008** and
- Nanodevices fabrication workshop and training useful in the area of energy was held between **26th and 30th of October, 2009** at the Engineering Materials Development Institute (EMDI), Akure.

2.1 Aims of the Workshop

In continuation of the Nigerian nanotechnology Initiatives and in order to kick-start our nanotechnology programs, it is necessary to have enough number of Nigerian experts involved in nano-science and technology research and development, hence the need to

- increase nanotechnology and nanosciences awareness within the country and
- have a critical mass of nano-experts in the established niche areas within the next 5 years.

2.2 Participants Selection Procedure

Advertisements were placed inside (i) government tender's journal and two of the most widely read daily newspapers in the country such as (ii) the Punch and (iii) the Guardian for participants interested in the nanoparticle production training and workshop to download, fill and send the required form to established e-mail addresses for the workshop within a stipulated time. (See appendix I and II)

The selection exercise was rigorous and 20 participants were selected for the training out of 200 candidates due to limited funding. Two trainers were also selected within the country to give lectures and demonstrations pertaining to the workshop (see appendix III).

2.3 Targeted Audience

In order to demystify the belief that nanotechnology is esoteric and research in the area can only be undertaken by selected few, the training targeted university researchers, research institutes as well as PhD students working in the aforementioned niche areas. Since nanotechnology spans a wide range of disciplines, senior as well as young researchers and PhD students from different disciplines such as physics, chemistry, pharmacy, food science and technology were selected for the training after the said careful screening exercise.

2.4 Feedback

The feedback after the training sessions indicated that it will be beneficial to the country if these trainings can be a yearly event at least for the next five (5) years. This will mean that at the end of the 5th year, we would have trained at least 100 participants. These participants also would have trained and supervised undergraduate students leading to increased capacity-building in this new and versatile areas of science and technology.

Figure 2.1: DG addressing the participants at one of the workshops

Figure 2.2: Photograph of participants at one of the workshops

Figure 2.3: Magnetic nanoparticles produced at one of the workshops

Figure 2.4: Silver nanoparticle produced at one of the workshops

3.0 NASENI's Nanotechnology Research Grant Scheme

Application-oriented research proposals aimed at solving national problems in the areas of nanotechnology for water purification and nanoparticle and nano-thin films production applicable in medicine, agriculture and energy are being invited from the academia and research institutes all over the country. The duration of the project is 1 year and can be extended for another 6 months subject to satisfactory performance. The grant, which will not cover the cost of equipment purchase, will cover the cost of consumables and analysis.

Due to limited funding, it was only possible to fund two (2) proposals during 2008-2011 fiscal years. The status of the proposals is given below;

(i) A grant has been allocated to a top researcher in the country for producing a prototype of MOCVD system for thin film preparation.

Remark: ***The MOCVD prototype has been designed, constructed, tested and delivered.***

(ii) A grant has also been allocated for silica production from agricultural waste products.

Remark: ***This project is still in progress***

(iii) A grant has again been allocated for the fabrication of plant fibre-reinforced thermoplastic composites.

Remark: ***Project in progress***

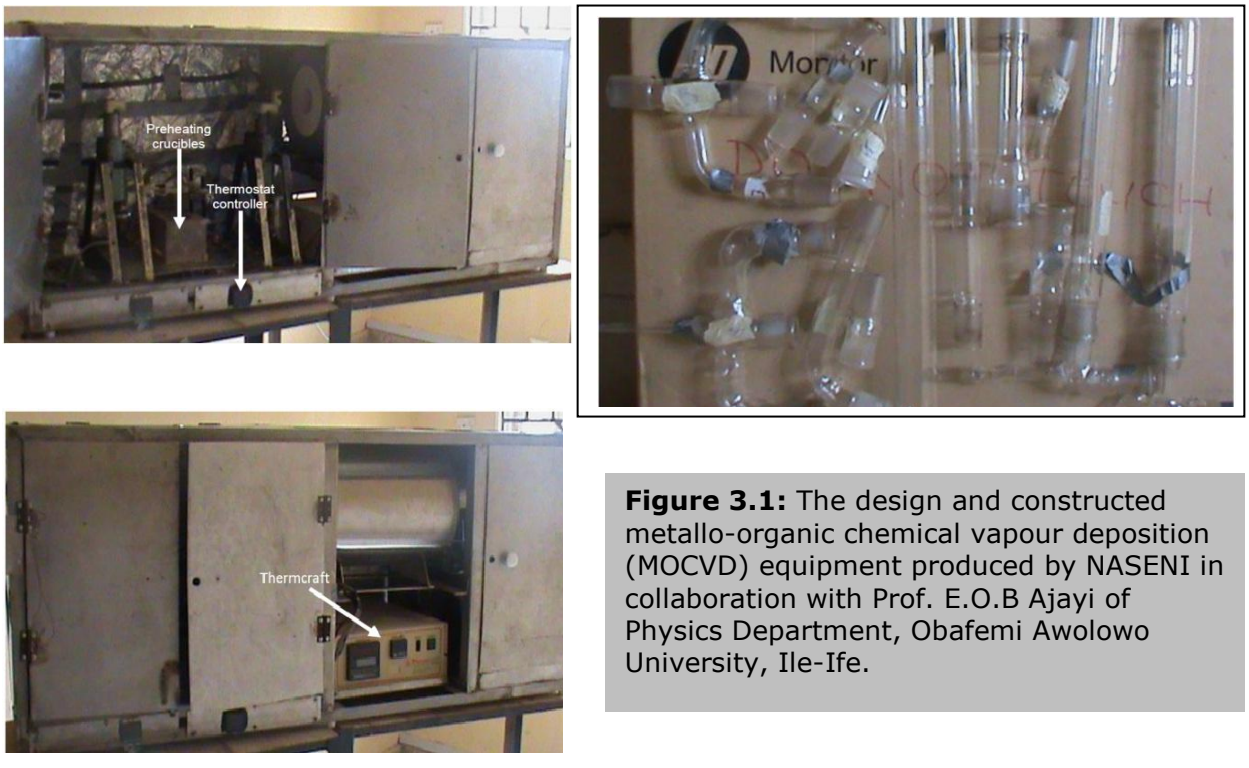


Figure 3.1: The design and constructed metallo-organic chemical vapour deposition (MOCVD) equipment produced by NASENI in collaboration with Prof. E.O.B Ajayi of Physics Department, Obafemi Awolowo University, Ile-Ife.