

5-2-2011

Request for Graduate Travel Support to Attend the Nanoelectronic Devices for Defense \$ Security (NANO-DDS) Conference 2009. To be Held Sept 28-Oct. 2, 2009 in Ft. Lauderdale FL

Carl P. Tripp

Principal Investigator; University of Maine, Orono, ctrip@maine.edu

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Final Report for Period: 04/2010 - 03/2011

Submitted on: 05/02/2011

Principal Investigator: Tripp, Carl P.

Award ID: 0941118

Organization: University of Maine

Submitted By:

Tripp, Carl - Principal Investigator

Title:

Request for Graduate Travel Support to Attend the Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference 2009. To be Held Sept 28-Oct. 2, 2009 in Ft. Lauderdale FL.

Project Participants

Senior Personnel

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Activities and Findings

Journal Publications

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Contributions

Conference Proceedings

Categories for which nothing is reported:

Organizational Partners

Activities and Findings: Any Research and Education Activities

Activities and Findings: Any Findings

Activities and Findings: Any Training and Development

Activities and Findings: Any Outreach Activities

Any Journal

Any Book

Any Web/Internet Site

Any Product

Any Contribution

Any Conference

The University of Maine provided support to thirteen student attendees at the 2009 Nanoelectronics Devices for Defense & Security (NANO-DDS) Conference. The students and the amount of support they received in attending the 2009 NANO-DDS Conference were:

minority	Last	First	affiliation	registration	banquet	travel	hotel	total
no	Abell	Justin	University of Georgia	\$ 300.00	\$ 100.00	\$ 323.20	\$ 336.17	\$ 1,059.37
yes	Hussin	Rozana	Carnegie Mellon University	\$ 300.00	\$ 100.00	\$ 253.60	\$ 523.80	\$ 1,177.40
yes	Tan	Zhongkui	Stony Brook University	\$ 300.00	\$ 100.00	\$ -	\$ 733.65	\$ 1,133.65
yes	Koukourinkova	Sabina	University of Arkansas	\$ 300.00	\$ 100.00	\$ 517.48	\$ 395.16	\$ 1,312.64
yes	Martinez-Troncos	Luisa	New Jersey City University	\$ 300.00	\$ 100.00	\$ 239.20	\$ 296.37	\$ 935.57
no	Johnson	Jason	U of Florida	\$ 300.00	\$ -	\$ -	\$ -	\$ 300.00
no	Boehme	Mario	Darmstadt University of Technology	\$ 300.00	\$ -	\$ 664.27	\$ 298.76	\$ 1,263.03
yes	Chen	Jianjun	University of New Orleans	\$ 300.00	\$ 100.00	\$ 234.89	\$ 142.04	\$ 776.93
yes	Cella	Lakshmi	UC Riverside	\$ 300.00	\$ 100.00	\$ 530.40	\$ 395.16	\$ 1,325.56
yes	Williams	Kimani	UCSB	\$ 300.00	\$ 100.00	\$ 380.35	\$ -	\$ 780.35
yes	Rahman	Masudur	Marshall University	\$ 300.00	\$ -	\$ -	\$ 493.95	\$ 793.95
no	Settingington	Emma	Michigan State University	\$ 300.00	\$ -	\$ -	\$ -	\$ 300.00
yes	Torres-Charolla	Edith	Michigan State University	\$ 300.00	\$ -	\$ -	\$ -	\$ 300.00
				\$ 3,900.00	\$ 800.00	\$ 3,143.39	\$ 3,615.06	\$ 11,458.45

The amount of financial assistance offered to each student is documented in the individual letters provided in this final report, and the amount offered varied only due to the cost of travel to the meeting, and to availability of funding.

All of the supported students participated in the technical program of the conference. The associated abstracts for the talks/posters are provided with this report.

As is clear from the attached information, the special student attendee program that was supported by the NSF funding was very successful in bringing young researchers to the NANO-DDS Conference which both broadened the academic experience of the students and enhanced the technical program at the meeting.



2009 Nanoelectronic Devices for Defense & Security Sept 28- Oct 2, 2009, Fort Lauderdale, Florida

Justin Abell
University of Georgia
jabell@uga.edu

Dear Justin Abell,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$300.00 to cover Travel to/from the Conference.
- (3) An Allowance of up to \$250.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.

IMPORTANT NOTES: To obtain the financial reimbursements listed in (2) and (3) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAFS**) and all associated receipts as these are records the conference must retain.

NOTE that it will be necessary to **follow all the instructions** that are included on the NANO-DDS-09-TAFS and NANO-DDS-09-SARF in completing and submitting the forms in order to achieve the financial reimbursements. Finally, the conference is not able to provide any cash advances before the conference dates.

The organizers of the 2009 NANO-DDS Conference would like to recognize the U.S. Army Research Office (ARO), the U.S. Air Force Office of Scientific Research (AFOSR), the U.S. National Science Foundation (NSF), and the Defense Advanced Research Projects Agency (DARPA) for contributing to the sponsorship of your travel.

Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



2009 Nanoelectronic Devices for Defense & Security Sept 28- Oct 2, 2009, Fort Lauderdale, Florida

Mario Boehme
Darmstadt University of Technology
Email: mboehme@ca.tu-darmstadt.de

Dear Mario Boehme,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$650.00 to cover Travel to/from the Conference.
- (3) An Allowance of up to \$300.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.

IMPORTANT NOTES: To obtain the financial reimbursements listed in (2) and (3) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAFS**) and all associated receipts as these are records the conference must retain.

NOTE that it will be necessary to **follow all the instructions** that are included on the NANO-DDS-09-TAFS and NANO-DDS-09-SARF in completing and submitting the forms in order to achieve the financial reimbursements. Finally, the conference is not able to provide any cash advances before the conference dates.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



**2009 Nanoelectronic Devices for Defense & Security
Sept 28- Oct 2, 2009, Fort Lauderdale, Florida**

Lakshmi Cella
University of California-Riverside
Email: lc001@ucr.edu

Dear Lakshmi Cella,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$400.00 to cover Travel to/from the Conference.
- (3) An Allowance of up to \$250.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.
- (4) Complementary Banquet Cruise ticket for Wednesday, Sept. 30th.

IMPORTANT NOTES: To obtain the financial reimbursements listed in (2) and (3) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAFS**) and all associated receipts as these are records the conference must retain.

NOTE that it will be necessary to **follow all the instructions** that are included on the NANO-DDS-09-TAFS and NANO-DDS-09-SARF in completing and submitting the forms in order to achieve the financial reimbursements. Finally, the conference is not able to provide any cash advances before the conference dates.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



**2009 Nanoelectronic Devices for Defense & Security
Sept 28- Oct 2, 2009, Fort Lauderdale, Florida**

Yuting Chen

RPI

Email: yuting.w.chen@gmail.com

Dear Yuting Chen,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

(1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)

IMPORTANT NOTES: To qualify for the waiver listed, the conference student-attendee must complete the following task after attending the conference.

(A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.

The organizers of the 2009 NANO-DDS Conference would like to recognize the U.S. Army Research Office (ARO), the U.S. Air Force Office of Scientific Research (AFOSR), the U.S. National Science Foundation (NSF), and the Defense Advanced Research Projects Agency (DARPA) for contributing to the sponsorship of your travel.

Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



2009 Nanoelectronic Devices for Defense & Security Sept 28- Oct 2, 2009, Fort Lauderdale, Florida

Rozana Hussin
Carnegie Mellon University
Email: rozana@cmu.edu

Dear Rozana Hussin,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$350.00 to cover Travel to/from the Conference.
- (3) An Allowance of up to \$250.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.

IMPORTANT NOTES: To obtain the financial reimbursements listed in (2) and (3) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAFS**) and all associated receipts as these are records the conference must retain.

NOTE that it will be necessary to **follow all the instructions** that are included on the NANO-DDS-09-TAFS and NANO-DDS-09-SARF in completing and submitting the forms in order to achieve the financial reimbursements. Finally, the conference is not able to provide any cash advances before the conference dates.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



**2009 Nanoelectronic Devices for Defense & Security
Sept 28- Oct 2, 2009, Fort Lauderdale, Florida**

Jason Johnson
University of Florida
jason.l.johnson@ufl.edu

Dear Jason Johnson,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

(1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)

IMPORTANT NOTES: To obtain the financial reimbursements listed in (1) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a copy of your registration receipt.

NOTE that it will be necessary to **follow all the instructions** that are included on the NANO-DDS-09-SARF in completing and submitting the forms in order to achieve the financial reimbursements. Finally, the conference is not able to provide any cash advances before the conference dates.

The organizers of the 2009 NANO-DDS Conference would like to recognize the U.S. Army Research Office (ARO), the U.S. Air Force Office of Scientific Research (AFOSR), the U.S. National Science Foundation (NSF), and the Defense Advanced Research Projects Agency (DARPA) for contributing to the sponsorship of your travel.

Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



**2009 NanoElectronic Devices for Defense & Security
Sept 28- Oct 2, 2009, Fort Lauderdale, Florida**

Sabina Koukourinkova
University of Arkansas
Email: skoukour@uark.edu

Dear Sabina Koukourinkova,

The organizers of the 2009 NanoElectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

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- (2) An Allowance of up to \$350.00 to cover Travel to/from the Conference.
- (3) An Allowance of up to \$250.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.
- (4) Complementary Banquet Cruise ticket for Wednesday, Sept. 30th.

IMPORTANT NOTES: To obtain the financial reimbursements listed in (2) and (3) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAFS**) and all associated receipts as these are records the conference must retain.

NOTE that it will be necessary to **follow all the instructions** that are included on the NANO-DDS-09-TAFS and NANO-DDS-09-SARF in completing and submitting the forms in order to achieve the financial reimbursements. Finally, the conference is not able to provide any cash advances before the conference dates.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



**2009 Nanoelectronic Devices for Defense & Security
Sept 28- Oct 2, 2009, Fort Lauderdale, Florida**

Masudur Rahman
Marshall University
Email: rahmanm@marshall.edu

Dear Rahman Masudur,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$500.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.

IMPORTANT NOTES: To obtain the financial reimbursements listed in (2) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAFS**) and all associated receipts as these are records the conference must retain.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



**2009 Nanoelectronic Devices for Defense & Security
Sept 28- Oct 2, 2009, Fort Lauderdale, Florida**

Emma Settingington
Michigan State University
Email: ebs@msu.edu

Dear Emma Settingington,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

(1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)

IMPORTANT NOTES: To qualify for the waiver listed, the conference student-attendee must complete the following task after attending the conference.

(A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.

The organizers of the 2009 NANO-DDS Conference would like to recognize the U.S. Army Research Office (ARO), the U.S. Air Force Office of Scientific Research (AFOSR), the U.S. National Science Foundation (NSF), and the Defense Advanced Research Projects Agency (DARPA) for contributing to the sponsorship of your travel.

Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



2009 Nanoelectronic Devices for Defense & Security Sept 28- Oct 2, 2009, Fort Lauderdale, Florida

Zhongkui Tan
Stony Brook University
Email: zhotan@ic.sunysb.edu

Dear Zhongkui Tan,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$250.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.
- (3) Complementary Banquet Cruise ticket for Wednesday, Sept. 30th.

IMPORTANT NOTES: To obtain the financial reimbursements listed the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAF**) and all associated receipts as these are records the conference must retain.

NOTE that it will be necessary to **follow all the instructions** that are included on the NANO-DDS-09-TAF and NANO-DDS-09-SARF in completing and submitting the forms in order to achieve the financial reimbursements. Finally, the conference is not able to provide any cash advances before the conference dates.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



2009 Nanoelectronic Devices for Defense & Security
Sept 28- Oct 2, 2009, Fort Lauderdale, Florida

Edith Torres-Charolla
Michigan State University
Email: torresch@msu.edu

Dear Edith Torres-Charolla,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

(1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)

IMPORTANT NOTES: To qualify for the waiver listed, the conference student-attendee must complete the following task after attending the conference.

(A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



2009 Nanoelectronic Devices for Defense & Security Sept 28- Oct 2, 2009, Fort Lauderdale, Florida

Luisa Troncoso
NJ City University
Email: lm0108@hotmail.com

Dear Luisa Troncoso,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$275.00 to cover Travel to/from the Conference.
- (3) An Allowance of up to \$300.00 to cover accommodations in the Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.

IMPORTANT NOTES: To obtain the financial reimbursements listed in (2) and (3) the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
- (B) Submit a fully completed version of the attached Travel-Assistance Form (i.e., **NANO-DDS-09-TAF**) and all associated receipts as these are records the conference must retain.

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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager



2009 Nanoelectronic Devices for Defense & Security Sept 28- Oct 2, 2009, Fort Lauderdale, Florida

Kimani Williams
University of California-Santa Barbara
Email: kimani_williams@umail.ucsb.edu

Dear Kimani Williams,

The organizers of the 2009 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to confirm your support for attending the 2009 NANO-DDS Conference during the week of Sept 28- Oct 2, 2009 in Fort Lauderdale, Florida. Specifically, you will be allowed the following Attendee-Assistance support:

- (1) Waiver of the Full Conference Registration Fee (\$300.00 will be paid on your behalf)
- (2) An Allowance of up to \$400.00 to cover travel to Fort Lauderdale, FL area during the week of Sept 27- Oct 2, 2009.
- (3) Complementary Banquet Cruise ticket for Wednesday, Sept. 30th.

IMPORTANT NOTES: To obtain the financial reimbursements listed the conference student-attendee must complete both of the following tasks after attending the conference.

- (A) Submit a fully completed version of the attached Student Attendee Report Form (i.e., **NANO-DDS-09-SARF**) as this is required for reporting to the conference sponsors.
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Best Regards

Dr. Hong-Liang Cui
2009 NANO-DDS
Conference Manager

SERS SUBSTRATES: LARGE SCALE FABRICATION AND HIGH THROUGHPUT SCREENING DEVICES

Justin Abell¹, HsiaoYun Chu¹, Jeremy Driskell^{1, 2}, Ralph Tripp^{1, 2}, Richard Dluhy^{1, 3}, and Yiping Zhao^{1, 4}

¹ NanoScience and Engineering Center, ²Department of Infectious Diseases, ³Department of Chemistry, and ⁴Department of Physics and Astronomy
University of Georgia, Athens Georgia 30602

SUMMARY: Oblique angle deposition has been used to fabricate silver nanorod arrays with large SERS enhancement. We aim to discuss the flexibility of this method to allow for substrate optimization and customization, incorporation into various analytical devices, and large-scale manufacturing.

The fabrication of large area, uniform and high enhancement substrates for surface enhanced Raman scattering (SERS) based sensing is a bottle-neck for practical applications of SERS. Recently using oblique angle deposition (OAD) method, we have fabricated silver nanorod arrays with SERS enhancement factor $> 10^8$, and SERS intensity variation $< 20\%$. These SERS substrates can be used to distinguish different viruses, bacteria, and their different strains, as well as important biomolecules such as micro RNAs. Here we will address the large scale manufacturing and fast screening issues of SERS substrates. With a unique designed prototype substrate holder (Fig. 1(a)), we can fabricate 10 1'x3' uniform SERS substrate simultaneously in one OAD deposition process. Those substrates can be patterned to yield 4×10 array of wells (Fig. 1(b)) for high speed chemical/biological agent screening and multiplexing detection. Those substrates can also be fabricated into flow cells (Fig. 1(c)) for dynamically monitoring chemical/biological processes using SERS technique. Similar fabrication method can also be applied to deposit Ag nanorod arrays onto plastic substrates to make larger area and flexible SERS substrates for other practical applications. The details on the fabrication and characterization of those substrates and devices will be discussed in this talk.

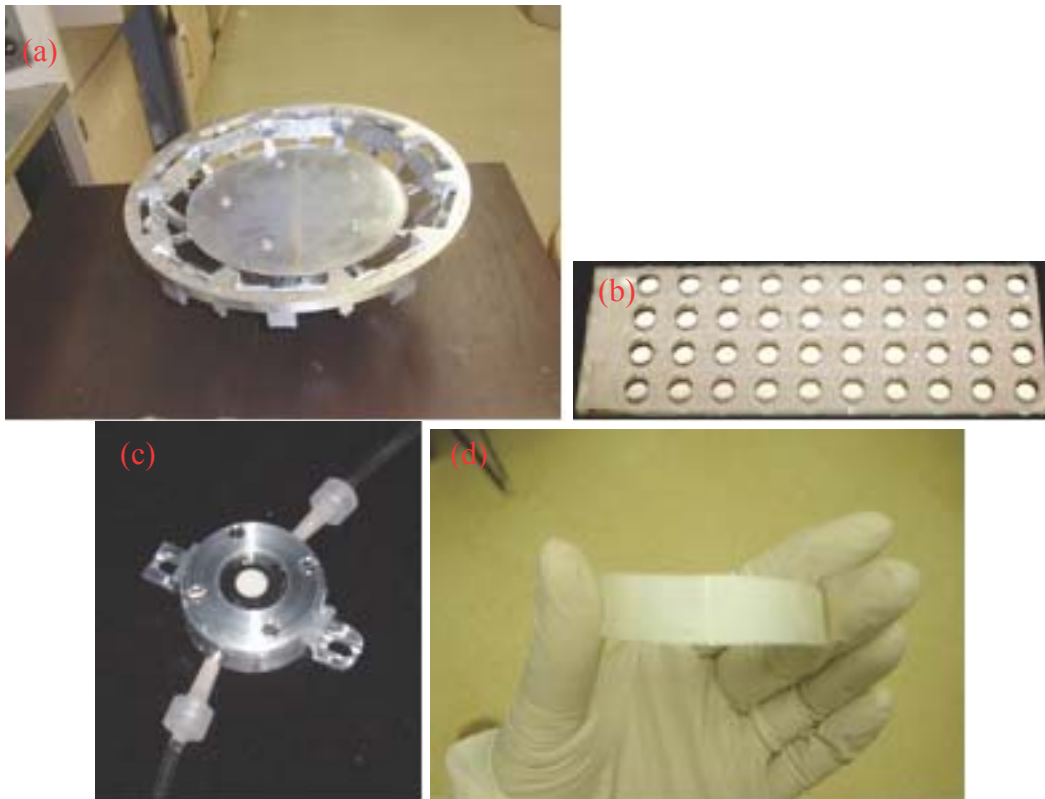


Figure 1. (a) Multiple SERS substrate holder for large scale fabrication; (b) a forty well microtiter SERS chip; (c) a fixed substrate SERS flow cell, and (d) a piece of flexible SERS substrate.

INVESTIGATION OF CHEMICAL SENSING WITH PRECISELY DEFINED MULTI-FUNCTIONALIZED CONDUCTING POLYMER NANOWIRE SENSORS

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Summary

We report a combinatorial chemical sensing study using a collection of differently functionalized conducting polymer nanowire (CPNW) sensors. These completely deterministic CPNWs and contact leads were fabricated using an innovative technique developed recently by our group. Results from nanowires that are made of poly(3,4-ethylenedioxythiophene) (PEDOT) and chemical derivatives of this polymer will be presented. Comprehensive investigations of CPNW sensing response to a series of organic chemicals as functions of doping level, type of dopants, and chemical functionalization of the CPNWs will be discussed. It is found that lower doping concentration tends to yield to higher sensitivity; and differently functionalized nanowires respond to distinctly different species – which leads to fingerprinting of different analytes using an array of heterogeneous CPNWs.

Conducting polymer nanowires (CPNW) have been demonstrated to have a wide variety of applications due to its unique electronic and chemical properties [1]. With their 1-dimensional current path and large surface to volume ratio, CPNWs are extremely promising materials for chemical and biological sensing applications. Recently, we have reported a novel technique which has allowed us to fabricate precisely defined sub-100nm structures of different CP materials side-by-side on a desired substrate [2]. In brief, as summarized in Figure 1, the approach includes: 1) electrochemical polymerization of monomers with metal electrode templates, and 2) transfer of CP nano-structures onto a separate substrate via an adhesion layer.

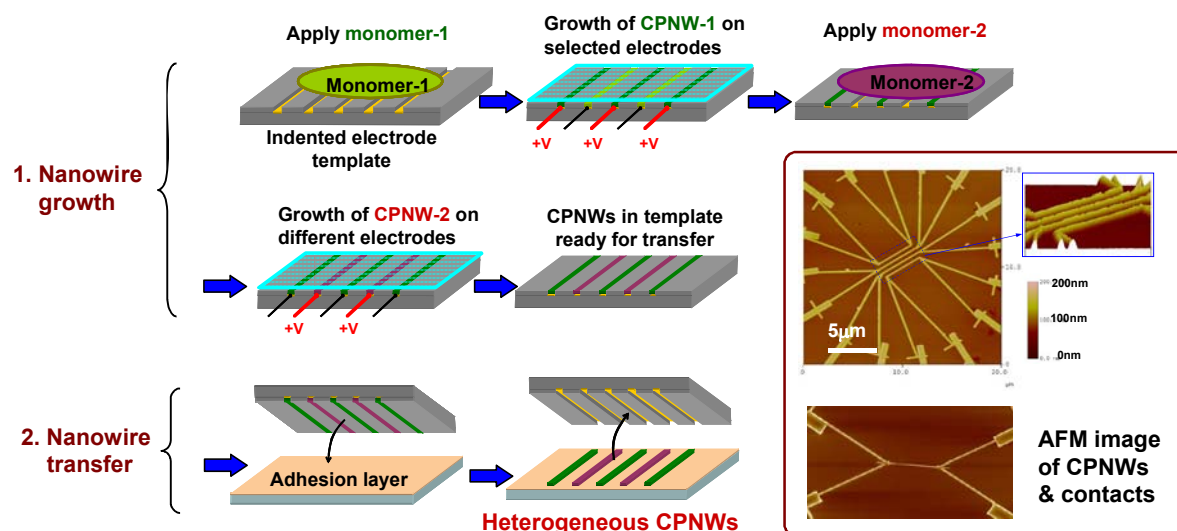


Figure 1. Schematic fabrication procedure and AFM images of precisely defined multi-functionalized CPNWs.

In this study, four different types PEDOT wires with ~100nm diameter were prepared, namely, i) PEDOT, ii) PEDOT/Hydroxy-functionalized EDOT (EDOT-OH), iii) PEDOT/carboxylic acid functionalized EDOT (EDOT-COOH) (all with Tetrabutylammonium hexafluorophosphate ($C_{16}H_{36}F_6NP$))

as electrolyte and dopant), and iv) PEDOT with Lithium Perchlorate (LiClO_4). PEDOT/EDOT-OH and PEDOT/EDOT-COOH were prepared by using mixtures of EDOT backbone monomers with EDOT-OH and EDOT-COOH monomers, respectively with a mol ratio of 5:1 (EDOT: functional group).

Chemical sensing is accomplished primarily by monitoring the resistance of each individual CPNW as they are exposed to an analyte. In this study, sensing response of the CPNWs to a collection of organic analytes, e.g. acetone, alcohol, chloroform, and hexane, etc has been investigated as functions of different chemical functionalization, dopant type, and doping level.

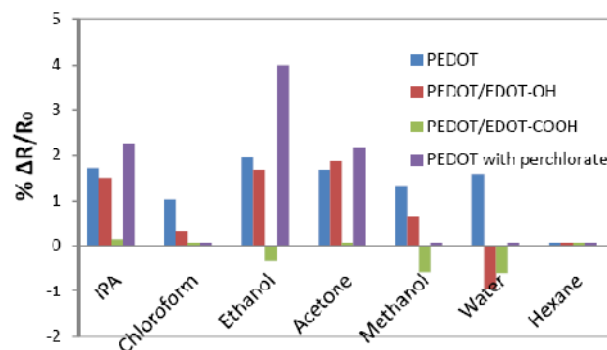


Figure 2. The sensing response of different PEDOT-based CPNWs to a series of analytes.

It is found that CPNWs with different chemical functional groups respond dramatically different to various analytes. Figure 2 shows resistive response data of four PEDOT based nanowires as they are exposed to some sample analytes. Each analyte has its own set of response from these four CPNWs. This provides a mechanism for fingerprinting various analytes with a library of characteristic nanowire sensor response vs. different chemical species. In this presentation, we will demonstrate that it is possible to accurately detect and differentiate individual species within a group of analytes with a combinatorial approach using an array of multi-functionalized CPNWs.

Conductivity of CPNW varies substantially with the dopant concentration. In this presentation, we will show that the sensitivity ($\Delta R/R_0$) of a CPNW sensor also varies significantly with the doping level. For example, shown in Figure 3, sensitivity of all four CPNWs to isopropyl alcohol (IPA) increases as the dopant concentration inside the nanowires decreases. We have found this trend is generally true for the polar species in a group of tested analytes, and not as clear for the non-polar species. Discussion on potential causes of this observation will be presented.

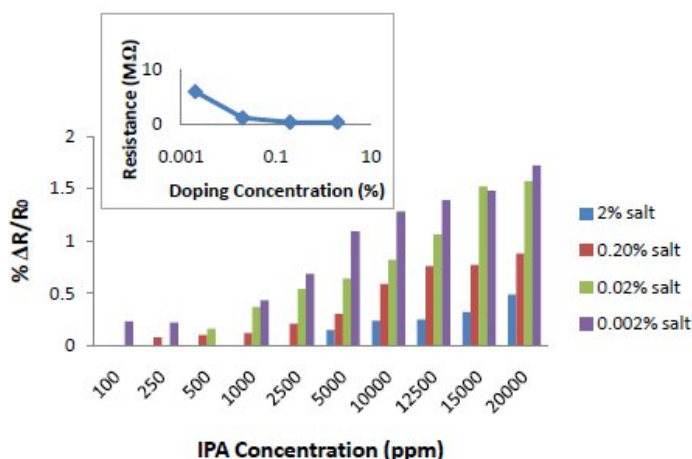


Figure 3. The sensitivity and (inset) resistance of EDOT CPNWs at varying doping concentration.

REFERENCES

1. Skotheim, T.A. and J.R. Reynolds, *Handbook of conducting polymers. Conjugated polymers : processing and applications*. 3rd ed. 2007, Boca Raton: CRC Press. 1 v. (various pages).
2. Chen, Y. and Y. Luo, *Precisely Defined Heterogeneous Conducting Polymer Nanowire Arrays – Fabrication and Chemical Sensing Applications*. *Advanced Materials*, 2009. **21**(20): p. 2040-2044.

RESISTIVE BISTABILITY IN METAL OXIDE JUNCTIONS

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SUMMARY: We are exploring nanoscale resistive bistability (memory) effects in junctions based on metal oxides, in the context of their possible applications in hybrid CMOS/nanoelectronic (e.g., CMOL [1]) circuits. So far, we have investigated junctions based on CuO_x , NbO_x and TiO_x layers formed by thermal and plasma oxidation, with or without rapid thermal post-annealing (at 200 to 800°C for 30 to 300 seconds). Resistive switching effects have been observed for all these materials. Particularly high endurance (over 1000 switching cycles) has been obtained for TiO_x junctions plasma oxidized in 15mTorr oxygen and then post-annealed at 700°C. However, the ON/OFF conductance ratio for these junctions is only about 5, and the sample-to-sample reproducibility is lower than that required for large scale integration. We have also extended our studies to multilayer TiO_x junctions and *a*-Si junctions with a Ag electrode, with the main goal to improve device reproducibility.

With the increasing need to find new ways of scaling, nanoscale memory cells for nonvolatile random access memory have attracted much attention recently. Especially, resistive random access memory (RRAM), based on simple bistable junctions, is one of the front runners since it may have a simple (1T0T) cell structure, fast access time and low operating voltage. Besides RRAM, the same junctions may be used in hybrid CMOS/nanoelectronic circuits which seem very promising for several digital and mixed-signal applications [1]. Currently, several research groups are exploring a broad variety of bistable junctions based on metal oxides, sulphides and amorphous silicon. While there is a virtual consensus that the mechanism of bistability is a reversible formation of localized conducting filaments, and good sample-to-sample reproducibility of device parameters (most importantly, the ON-OFF switching thresholds) has been demonstrated by some groups (see, e.g., Ref. 2), unfortunately, the conditions of the reproducibility are not clear yet. Our experiments are an effort to understand its conditions.

Our resistive switching device is just a few-nm-thick layer of a metal oxide sealed between two different thin-film metallic electrodes. We have explored several metal oxides, including copper oxides, niobium oxides and titanium oxides fabricated by thermal and plasma oxidation. After the completion of device fabrication, some devices are post annealed at 200 to 800°C for 30 to 300 seconds to improve structural and electric properties. In our first few attempts, we have observed resistive switching phenomenon at certain post-annealing conditions of all three metal oxide devices. The most reproducible results for single oxide layer junctions have been obtained by plasma oxidation of Ti base electrodes in 15mTorr oxygen, with Nb counter-electrodes. After post annealing at 700°C for 30 seconds, these devices are able to perform endurable switching (over 1000 cycles) with a low operating voltage (<4V), but the OFF/ON resistance ratio (Fig. 1) is too low for most prospective applications.

For us, these results, as well as the HPL group results [3], were the motivation to explore devices with several metal oxide layers. Multilayer TiO_x devices have been fabricated by several (5-10) plasma oxidation cycles of thin-film base Ti layer (with Pt and Ti counter-electrodes). Most of junctions fabricated in this way exhibit resistive bistability even before post annealing. Rapid post-annealing, within a certain range of duration and temperature, improves the OFF/ON resistance ratio (Fig. 2), though the sample-to-sample reproducibility is still low.

Following the work at Ann Arbor [2], we have also started to explore devices based on amorphous silicon based devices, but several important improvements still have to be made in their fabrication process flow.

In parallel, we are working on fabrication of interface between specially designed CMOS chips, fabricated in a silicon foundry, and a nanowire crossbar, with bistable devices at each crosspoint, with the goal to demonstrate first hybrid CMOS/nanoelectronic circuits.

The work is supported in part by AFOSR.

REFERENCES

- [1] K. K. Likharev, Hybrid CMOS/Nanoelectronic Circuits: Opportunities and Challenges, *J. Nanoelectronics and Optoelectronics*, vol. 3, pp. 203–230, 2008.
- [2] S. H. Jo and W. Lu, CMOS compatible nanoscale nonvolatile switching memory, *Nano Letters*, vol. 8, pp. 392-397, 2008.
- [3] Z. Li, M. D. Pickett, D. Stewart, D. A. A. Ohlberg, X. Li, E. Wu, W. Robinett, and R. S. Williams, Experimental demonstration of a defect-tolerant nanocrossbar demultiplexer, *Nanotechnology*, vol. 19, art. 165203, 2008.

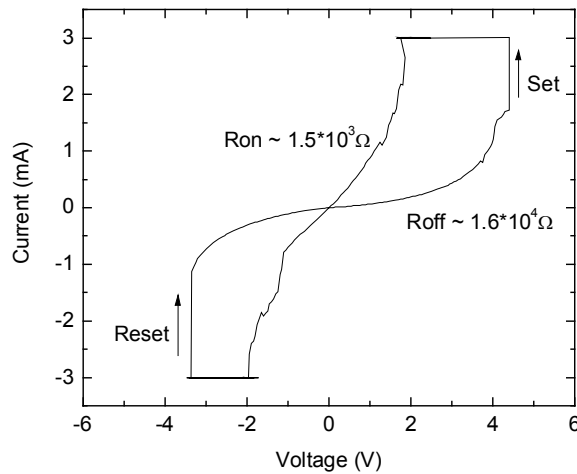


Figure 1. Bistable I - V curve of a typical single layer TiO_x device.

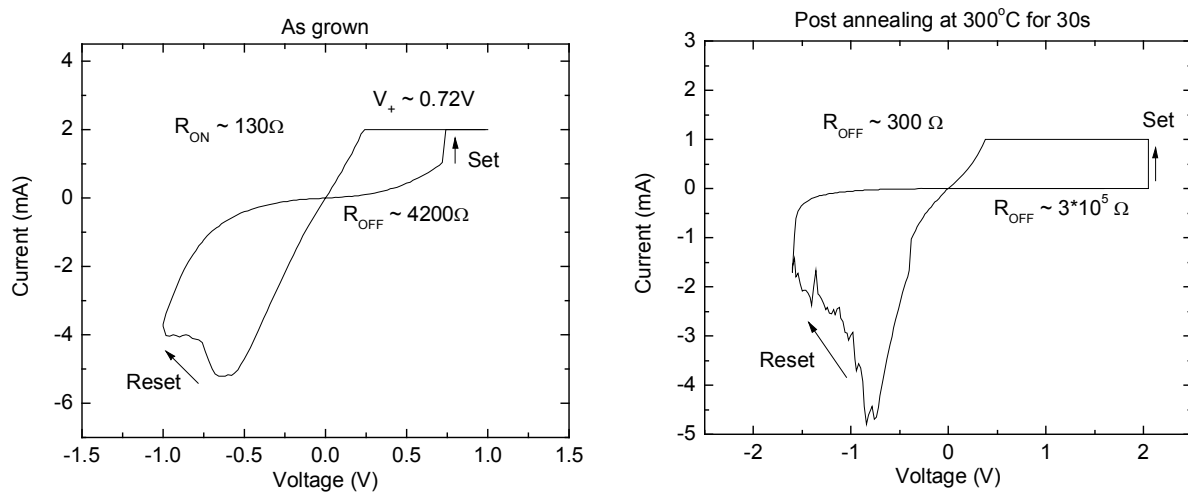


Figure 2. I - V curves of multilayer TiO_x devices from the same wafer.

ORDERED GA NANODROPLETS FOR MOLECULAR BEAM EPITAXY

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SUMMARY: Ordering of self-assembled Ga nanodroplets on GaAs (001) substrates during ion sputtering was investigated for variable ion beam parameters: incident angle, ion energy, current, and sputter time. Results show that ordering takes place at off-normal incidence during low-energy ion sputtering. In addition, a linear relationship between the ordering of the droplets and the current, and the ordering of the droplets and sputter time was found. The arrays of ordered droplets will be used to investigate the effect of molecular beam epitaxy on the morphological evolution of droplets.

Apart from other growth techniques, droplet epitaxy provides the advantage of fabricating self-assembled nanostructures on both lattice-matched and lattice-mismatched systems. Previous research involves droplet-assisted epitaxial growth of nanostructures such as nanoholes [1-3], quantum dots [4-6], quantum rings [2,7-9] and quantum dot molecules and clusters [10-12] without any ordering. However, epitaxial growth of ordered nanostructures will allow study of new opto-electronic properties, which will be incorporated in the fabrication of semiconductor devices. Thus, current research focuses on ordering nanostructures. Hexagonally ordered quantum dots have already been achieved by means of low energy Ar^+ ion sputtering for a variety of substrates such as Si [13], Ge [14], InSb [15], InP [16], and GaSb [17] with simultaneous stage rotation at off-normal incidence and without stage rotation at normal incidence. Also, hexagonal ordering of Ga nanodroplets independent of crystallographic orientation was recently reported for off-normal Ga^+ ion bombardment without simultaneous sample rotation [18]. Wei et al. proposed a theoretical model for self-assembly of ordered Ga nanodroplets explaining the affinity for droplet ordering at off-normal incident angle. The model is based on directional preferential sputtering of As from the droplet and local implantation of Ga onto the substrate, as well as anisotropic distribution of energy on the surface of the wafer. Here, we present that ordering of Ga nanodroplets is indeed reproducible while epitaxial growth of ordered nanostructures requires further research. Figure 1 shows the evolution of self-assembled droplets from being randomly distributed to forming ordered arrays.

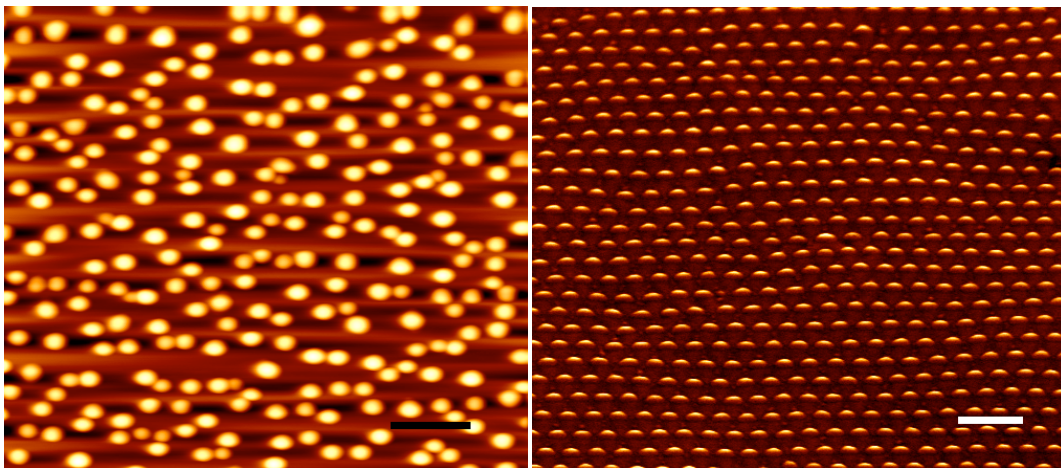


Figure 1. Ga nanodroplets formed on GaAs (001) substrate by means of: (1) molecular beam epitaxy (AFM image on the left), and (2) Ga^+ ion beam sputtering (SEM image on the right); scale bar 300nm.

In this investigation, the ion sputtering was carried out on epi-ready semi-insulating GaAs (001) substrates using SEM/FIB FEI Nova 200 Nanolab equipped with Ga⁺ ion beam source for variable incident angle, beam energy, current, and sputter time. Scanning electron microscopy (SEM) and atomic force microscope (AFM) were used for analysis of the evolution of surface morphology.

More specifically, experiments were carried out at incident angles from 0° to 62°, measured from the direction of the ion beam to the normal of the substrate, at ion energy 5keV, constant current (29pA, 70pA, 0.12nA, 0.23nA, 0.60nA, and 1nA), bombardment time 5 min and dwell time 1 μsec. Results show that formation of self-assembled chains of ordered Ga nanodroplets takes place at an incident angle greater than 30°. The effect of ion beam energy on the formation of ordered droplets was also studied for an incident angle of 37°, sputter time 5 min, dwell time 1 μsec, and constant flux. Droplet ordering was observed for low ion beam energy (5keV) while higher energy beam (10keV and 20keV) produced random distribution of droplets. Further, we researched the degree of ordering as a function of different current values (0.12nA, 0.23nA, 0.60nA) at beam energy 5keV, incident angle 37°, sputter time 15 min, dwell time 1 μsec, and a linear relationship was observed. Similarly, the ordering of droplets improved for increasing sputter time from 5 min to 60 min; however, at some critical sputter time the improvement in ordering was either disrupted and showed reversible behavior, or, in other instances, saturation in ordering occurred. The critical sputter time seems to be coupled to the parameters incident angle and current.

REFERENCES:

- [1] Zh. M. Wang, B. L. Liang, K.A. Sablon, and G. J. Salamo, *Appl. Phys. Lett.* **90**, 113120 (2007).
- [2] A. Stemmann, Ch. Heyn, T. Köppen, T. Kipp, and W. Hansen, *Appl. Phys. Lett.* **93**, 123108 (2008).
- [3] Ch. Heyn, A. Stemmann, W. Hansen, *J. Cryst. Growth* **311**, 1839 (2009).
- [4] Ch. Heyn, A. Stemmann, A. Schramm, W. Hansen, *J. Cryst. Growth*, **311**, 1825 (2009).
- [5] T. Mano, T. Kuroda, K. Mitsuishi, T. Noda, K. Sakoda, *J. Cryst. Growth* **311**, 1828 (2009).
- [6] B. L. Liang, Zh. M. Wang, J. H. Lee, K. Sablon, Yu. I. Mazur, and G. J. Salamo, *Appl. Phys. Lett.* **89**, 043113 (2006).
- [7] C. Zhao, Y. H. Chen, B. Xu, C. G. Tang, Z. G. Wang, F. Ding, *Appl. Phys. Lett.* **92**, 063122 (2008).
- [8] C. Z. Tong, and S. F. Yoon, *Nanotechnology* **19**, 365604 (2008).
- [9] Shesong Huang, Zhichuan Niu, Zhidan Fang, Haiqiao Ni, Zheng Gong, and Jianbai Xia, *Appl. Phys. Lett.* **89**, 031921 (2006).
- [10] K.A. Sablon, J. H. Lee, Zh. M. Wang, J. H. Shultz, and G. J. Salamo, *Appl. Phys. Lett.* **92**, 203106 (2008).
- [11] J. H. Lee, K. Sablon, Zh. M. Wang, and G. J. Salamo, *J. Appl. Phys.* **103**, 054301 (2008).
- [12] B. L. Liang, V. G. Drogan, Yu. I. Mazur, N. W. Strom, J. H. Lee, K. A. Sablon, Zh. M. Wang, and G. J. Salamo, *J. Nanosci. Nanotechnol.* **9**, 3320 (2009)
- [13] R. Gago et al., *Phys. Rev. B* **73**, 155414 (2006).
- [14] B. Ziberi, F. Frost, and B. Rauschenbach, *Appl. Phys. Lett.* **88**, 173115 (2006).
- [15] F. Frost, B. Ziberi, T. Hocher, and B. Rauschenbach, *Nucl. Instrum. Methods Phys. Res., Sect. B* **216**, 9 (2004).
- [16] F. Frost, A. Schindler, and F. Bigl, *Phys. Rev. Lett.* **85**, 4116 (2000).
- [17] S. Facsko et al., *Science* **285**, 1551 (1999).
- [18] Qiangmin Wei, Jie Lian, Wei Lu, Lumin Wang. *Phys. Rev. Lett.* **100**, 076103 (2008).

SYNTHESIS OF 9,9-DIOCTYLFLUORENYL-FLUORENE BRIDGED O-8-QUINOLATE TRIFLATE LIGAND

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New organic and inorganic compounds that exhibit unique fluorescent properties have been synthesized in the past and are being studied for various applications that involve their ability to emit light at certain wavelengths. Molecular architectural design and their macroscopic properties will dictate the material properties and their use in small photo and electro-optical materials. The design and fabrication of nanostructures can serve as building blocks for nano-optical systems, particularly novel electro-optical material and devices that are of immense interest to the scientific, defense and technology sectors. An area that is currently under intensive investigation focuses on the development of molecular systems capable of performing logic operations and consisting of multi-component light-emitting organic and metal-organic compounds having numerous applications in: chemosensors, chromonic liquid-crystalline materials, organic light-emitting diodes (OLED) s, photovoltaic and electrochromic materials. Fine-tuning the changes in ligands, the guest binding site and the medium surrounding these metal-organic complexes can be used to vary the luminescent, electronic and communication properties of inorganic materials to obtain desirable photo physical properties.

The goal of this research is to synthesize Fluorene based luminescent compound and determine the effects of lengthening the fluorine groups in the molecule. Recently, fluorene adducts have been used to form materials with interesting luminescent properties. The emission spectra of organic polymer blends of thiophene and diarylfluorene units were found to be controlled by varying the chain length of thiophene core.¹ Fluorine has several inherent qualities that make it a perfect candidate for the synthesis of novel light emitting compounds. Taking advantage of the luminescent properties of Fluorene, longer and more complex luminophores can be made that have longer lifespan and more efficient luminescence compared to current OLED luminophores. We intend to use part of the synthetic route used by Kelly et. als.² to create metal-based ligands that should yield interesting luminescent behavior.

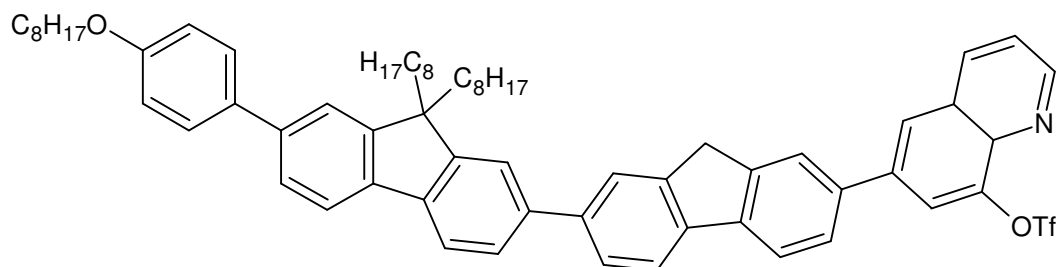


Figure 1. Target O-8-Quinolinate Triflate Ligand

References

- [1] K.-T. Wong, C.-F. Wang, C. Chou, Y.O. Su, G.-H. Lee, S.-M. Peng. Synthesis and Properties of Novel Thiophene-Based Conjugated Homologues: 9,9-Diphenylfluorene-Capped Oligothiophenes. *Org. Lett.*, 4(25), **2002**, 4439-4442.
- [2] W.C. Tsoi, M. O'Neill, M.P. Aldred, S.P. Kitney, P. Vlachos, S.M. Kelly. Distributed Bilayer Photovoltaics Based on Nematic Liquid Crystal Polymer Network. *Chem. Mater.*, 19, **2007**, 5475-5484.

LARGE AREA, TRANSPARENT, CONDUCTIVE GRAPHENE NANORIBBON NETWORK GAS SENSORS

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SUMMARY: We investigate the electrical and structural properties of room temperature processed, large area, transparent, conductive graphene nanoribbon networks and demonstrate their ability to detect ammonia at low ppm levels. Several groups have obtained graphene in individual sheets or few-layers by either liquid exfoliation from expandable graphite, chemical conversion from graphene oxide (GO), or CVD grown graphene. In this talk, we show that expandable graphite (EG) can be treated with surfactant solutions and high energy sonication to obtain few-layer graphene nanoribbons which can be filtered and transferred onto large area silicon substrates with excellent repeatability and with little time and cost. We then experimentally demonstrate the application of the fabricated graphene nanoribbon networks for gas sensing at room temperature. This work demonstrates the potential of large area graphene nanoribbon networks for chemical sensing applications.

The few-layer graphene (FLG) nanoribbon networks were fabricated using liquid exfoliation and vacuum filtration. To confirm that they are both conductive and transparent, we patterned the films into four-point probe structures using simple photolithography techniques and plasma etching. We find that the graphene nanoribbon networks have reasonable conductivity in the range from 25 to 65 S/cm at room temperature, and demonstrate excellent transmittance, greater than 80% in the visible regime and over 90% in IR and near IR range measured by FTIR and UV/Vis spectroscopy.

Figure 1(a) and 1(b) show the SEM image and Raman spectrum, respectively, of the FLG nanoribbon networks. The Raman spectrum shows the characteristic peaks of multi-layer graphene sheets [1].

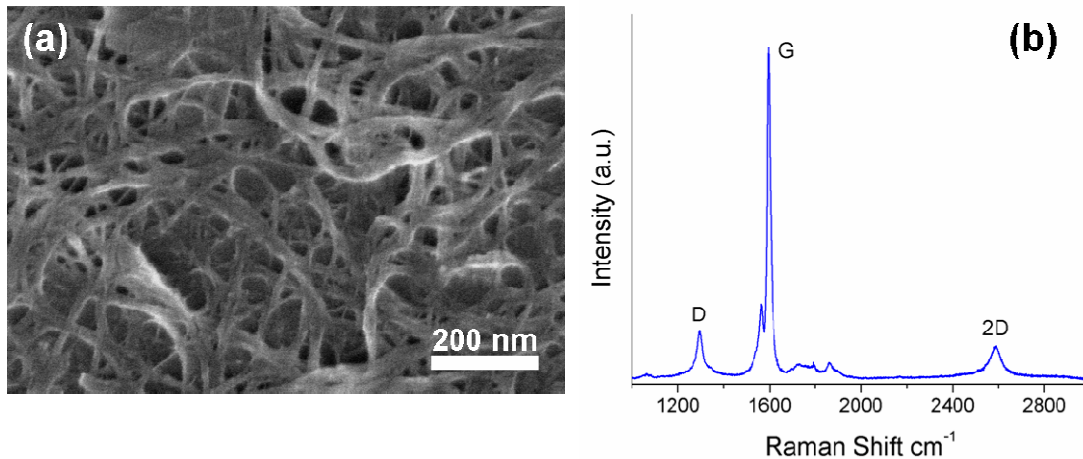


Figure 1. (a) SEM image and (b) Raman spectrum of the few-layer graphene nanoribbon network on an Si/SiO₂ substrate.

After fabrication, we demonstrate the potential of FLG nanoribbon networks for ammonia gas detection at low ppm levels. The permissible exposure limit (PEL) in the United States set by OSHA for employees exposed to a chemical substance is 50 ppm [2]. Because NH_3 is both caustic and hazardous it is imperative to monitor its presence. We found that our FLG nanoribbon networks are highly sensitive to NH_3 at ppm levels and demonstrate excellent recovery and repeatability upon measuring for several ON/OFF cycles. Figure 2(a) shows the percent relative resistance response ($\Delta R/R$) as a function of time when the graphene nanoribbon network is exposed to several cycles of 50 ppm NH_3 in nitrogen. The positive value of $\Delta R/R$ results from the depletion of holes by charge transfer from the *p*-type graphene network. In Fig. 2(a), we observe excellent sensor recovery towards its initial resistance state upon exposure to air. Furthermore, we have functionalized the graphene nanoribbon networks by evaporating a very thin layer of platinum (Pt). Pt functionalization significantly improves sensitivity of the device exposed to 50 ppm NH_3 from 20% to 70%, as demonstrated in Fig. 2(a). Figure 2(b) shows $\Delta R/R$ versus ppm concentration for the graphene nanoribbon network with and without Pt functionalization. For both cases, the sensitivity monotonically increases for increasing NH_3 ppm values.

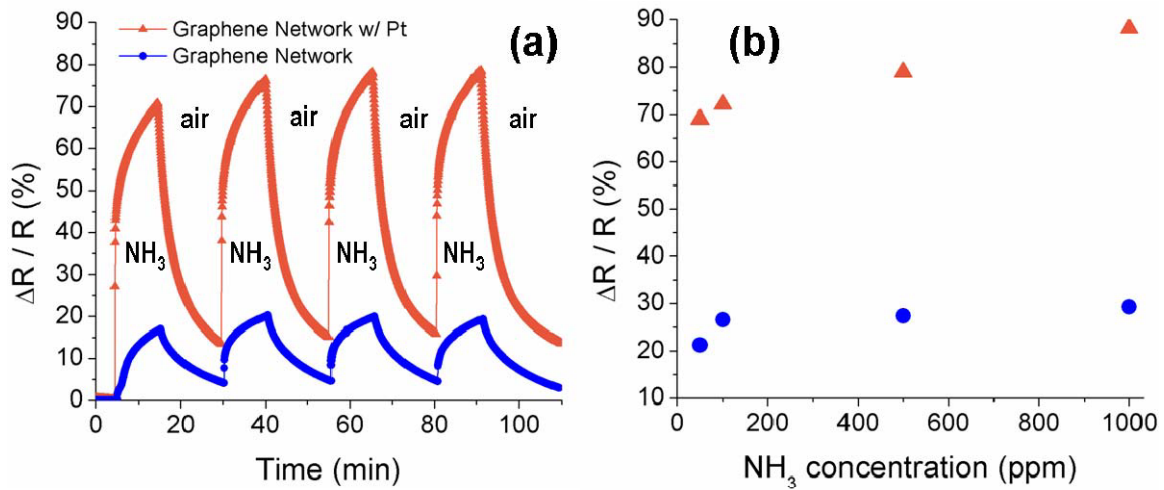


Figure 2. (a) Percent relative resistance response ($\Delta R/R$) as a function of time when the graphene nanoribbon network with and without Pt functionalization is exposed to several cycles of 50 ppm NH_3 in nitrogen. (b) $\Delta R/R$ versus ppm concentration for the graphene nanoribbon network with (orange triangles) and without (blue circles) Pt functionalization.

In summary, we have fabricated a simple and efficient gas sensor based on FLG nanoribbon networks and demonstrated large relative changes in resistance upon exposure to ppm levels of ammonia at room temperature. In addition, upon functionalizing the surface of our FLG nanoribbon networks, we have achieved even higher sensitivity. This work demonstrates the potential of large area graphene nanoribbon networks for chemical sensing applications.

REFERENCES

- [1] K. S. Kim, Y. Zhao, H. Jang, S. Y. Lee, J. M. Kim, K. S. Kim, J. -H. Ahn, P. Kim, J. -Y. Choi, and B. H. Hong, "Large-scale pattern growth of graphene films for stretchable transparent electrodes," *Nature* **457**, 706 (2009).
- [2] http://www.osha.gov/dts/chemicalsampling/data/CH_218300.html#exposure

FABRICATION OF ZINC OXIDE NANOTUBES BY ELECTROLESS DEPOSITION IN ION TRACK ETCHED TEMPLATES

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SUMMARY: Semi conductive nanostructures have reached strong significance in science and engineering. For many of these materials are now reliable synthesis available and a wide range of applications in all areas of nanoscience and nanotechnology have become possible. In case of semi conductive nanomaterials zinc oxide seems to be very interesting as a result of its piezoelectricity, large band gap (3.37 eV) and high exciton binding energy (60 meV). Nanotubes consisting of zinc oxide were induced by electroless deposition using ion track etched polycarbonate templates. Due to a selective etching process the ion tracks where prepared to the desired diameter of the zinc oxide nanotubes outer diameter later fabricated. Zinc oxide nanotubes with a diameter of minimum 80 nm and a wall thickness of minimum 15 nm can be fabricated using this method. To achieve nanotubes with thin walls and small surface roughness the tubes were generated by a several steps containing procedure under aqueous conditions. The below reported approach will process open end nanotubes with well defined outer diameter and wall thickness. Due to its surface limitation electroless deposition is a convenient and power saving manner to engender hollow nanostructures.

Due to its characteristics zinc oxide nanostructures could have novel applications in optoelectronics, sensors and biomedical sciences [1-3].

For fabrication of zinc oxide nanostructures there have been miscellaneous methods like pulsed laser deposition [4], vapour phase thermal sublimation technique [2] or chemical vapor deposition [5] developed and used. Fabricating metal nanostructures the template deposition method, pioneered by C.R. Martin [6, 7], is one of the important processes. So far, various types of nanostructures obtained by electroless deposition have been successfully fabricated using chemical and physical methods [8-10]. However, synthesis of zinc oxide nanotubes by electroless deposition has not been reported, yet.

In this announcement, we describe an effective synthesis of zinc oxide nanotubes with a diameter of minimum 80 nm and a wall thickness of minimum 15 nm. The zinc oxide nanotubes were grown by electroless deposition under aqueous conditions in ion track etched polycarbonate templates. The template will consist of polycarbonate foils with a thickness of 30 μ m (Makrofol N, Bayer) [11]. Using this method we are able to produce nanotube arrays from up to 10⁹ tubes per cm² having a tube length up to 30 μ m, single tubes are possible also. Due to its surface limitation electroless deposition is a convenient and power saving manner to engender hollow nanostructures. The SEM image in Fig. 1 shows bulk zinc oxide nanotubes unhinged from the polycarbonate template containing 10⁷ tubes per cm². As expected, the nanotubes have open ends, indicating that the deposition of zinc oxide solely occurred on the etched ion track walls. The SEM image in Fig. 2 shows a single nanotube that has three open ends due to a Y-intersection. The wall thickness of the tubes is linear related to the electroless deposition conditions. With short deposition time tubes were achieved, while overstay deposition time increased the wall thickness and nanowires were obtained finally. The reproducibility of the deposition method using polycarbonate templates was investigated by a survey over a significant number of examinable tubes by different deposition times. The structural properties of the grown zinc oxide tubes were investigated by using various analytic techniques. The growth mechanism of the zinc oxide nanotubes was proposed on the basis of experimental results. Other nanotubes consisting of titanium dioxide, tin oxide, indium tin oxide and samarium oxide have been induced with this method.

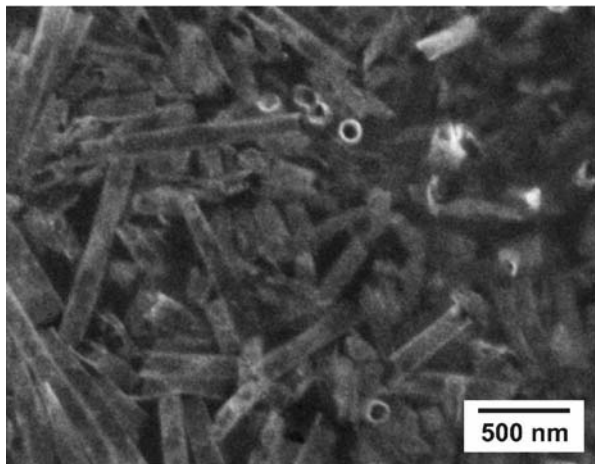


Figure 1. SEM image of bulk zinc oxide nanotubes unHINGED out of the polycarbonate template.

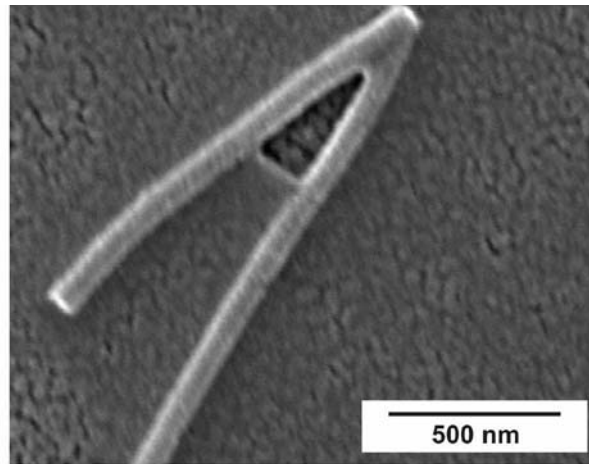


Figure 2. SEM image of single zinc oxide nanotube with three open ends.

REFERENCES

- [1] L.A. Pozhar and W. Mitchel, "Opto-Electronic Properties and Stability of Artificial Zinc Oxide Molecules", 2006 MRS Fall Meeting, Nov. 27 – Dec. 1, Abstract # I7.39, 206 (2006)
- [2] Zinc oxide nanostructures: growth, properties and applications Zhong Lin Wang 2004 J. Phys.: Condens. Matter 16 R829-R858
- [3] M.H. Huang, et al., "Room-temperature ultraviolet nanowire nanolasers," Science, 292(5523):1897-9, 8 June 2001. [U. Calif., Berkeley; L. Berkeley Natl. Lab., CA] *440WY
- [4] M. Grundmann, A. Rahm, T. Nobis, H. Wenckstern, C. Czekalla, J. Lenzner, M. Lorenz „Growth and Characterization of Optical and Electrical Properties of ZnO Nano- and Microwires“ Materials Research Society
- [5] Tae Yun Kim, Seung Hyun Lee, Young Hwan Mo, Kee Suk Nahm†, Ji Young Kim, Eun Kyung Suh and Moon Kim “Growth Mechanism of Needle-shaped ZnO Nanostructures over NiO-coated Si Substrates” Korean J. Chem. Eng., 21(3), 733-738 (2004)
- [6] Charles R. Martin “Nanomaterials: A Membrane-Based Synthetic Approach” Science 23 December 1994: Vol. 266. no. 5193, pp. 1961 – 1966
- [7] J. D. Klein, R. D. Herrick II, D. Palmer, and M. J. Sailor, Chem. Mater. 5, 902 (1993).
- [8] Lon A. Porter, Jr., Hee Cheul Choi, Alexander E. Ribbe, and Jillian M. Buriak “Controlled Electroless Deposition of Noble Metal Nanoparticle Films on Germanium Surfaces” Nano Letters, 2002, 2 (10), pp 1067–1071
- [9] Valenzuela, K.; Raghavan, S.; Deymier, P.A.; Hoying, J. “Formation of Copper Nanowires by Electroless Deposition Using Microtubules as Templates” Journal of Nanoscience and Nanotechnology, Volume 8, Number 7, July 2008 , pp. 3416-3421(6)
- [10] Zhongliang Shi et al “Self-assembled palladium nanowires by electroless deposition” 2006 Nanotechnology 17 2161-2166
- [11] N. Chtanko, M. E. Toimil Molares, T. Cornelius, D. Dobrev, and R. Neumann “Etched Single-Ion-Track Templates for Single Nanowire Synthesis” J. Phys. Chem. B, 2004, 108 (28), pp 9950–9954

WELL-ALIGNED METAL OXIDE NANOWIRE ARRAYS FOR HIGHLY SENSITIVE AND SELECTIVE GAS DETECTION

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SUMMARY: Multiple well-aligned ZnO nanowire array sensors have been fabricated through combined different techniques, such as physical vapor deposition, conventional photolithography, and e-beam lithography. The gas sensors showed room-temperature responses to some environmental toxic gases, such as NO₂ and H₂S, down to sub-ppm level with a relatively fast response time (several minutes). A sensor prototype with four different surface materials coating on a single nanowire chip has been demonstrated for selective detection, in which principle component analysis (PCA) was used as the major pattern recognition algorithm for gas discrimination.

Vertically aligned nanowire arrays provide several key features, including large surface area, high surface aspect ratio and three-dimensional structural profile for efficient gas molecule absorption and desorption, making them extremely useful in highly sensitive gas detection. [1, 2] And further, surface modifications can be readily realized on nanowire array platform for selective gas detection. [3] In this report, multiple well-aligned ZnO nanowire array sensors have been created through combined different techniques, such as physical vapor deposition, conventional photolithography, and e-beam lithography. The gas sensors showed room-temperature responses to some environmental toxic gases, such as NO₂ and H₂S, down to sub-ppm level with a relatively fast response time (several minutes). The sensor arrays also showed cross-reactive responses to different gases when applied different surface coatings. A device prototype with four different surface materials coatings has been demonstrated for selective detection, in which principle component analysis (PCA) [4] was used as the major pattern recognition algorithm for gas discrimination.

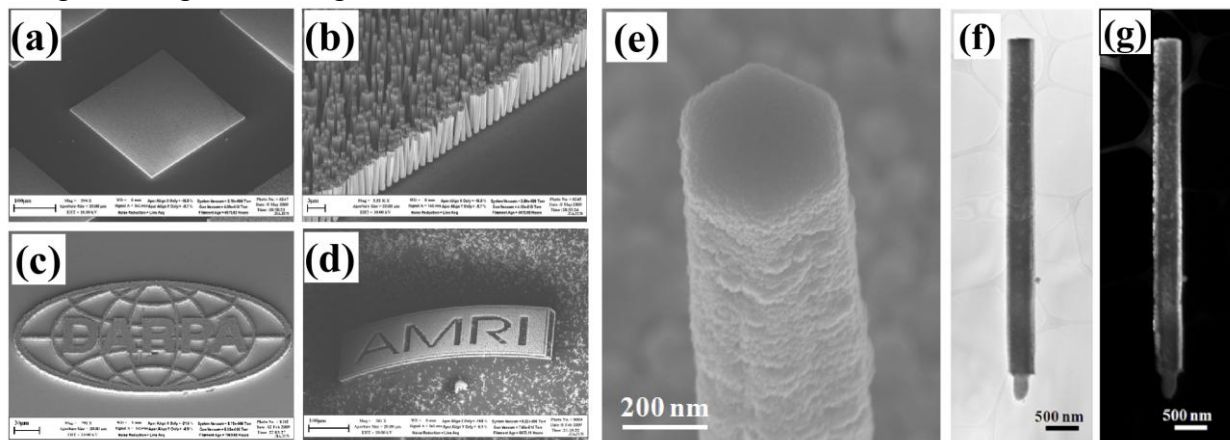


Figure 1 Patterned growth of ZnO nanowire arrays on (a, b) Si/SiO₂ substrates, (c) transparent conducting oxide substrates, and (d) Kapton plastic substrates. FESEM images (e) and bright field (f) and dark field (g) TEM images showing ZnO nanowires coated with SnO₂ nanoparticles via RF sputtering.

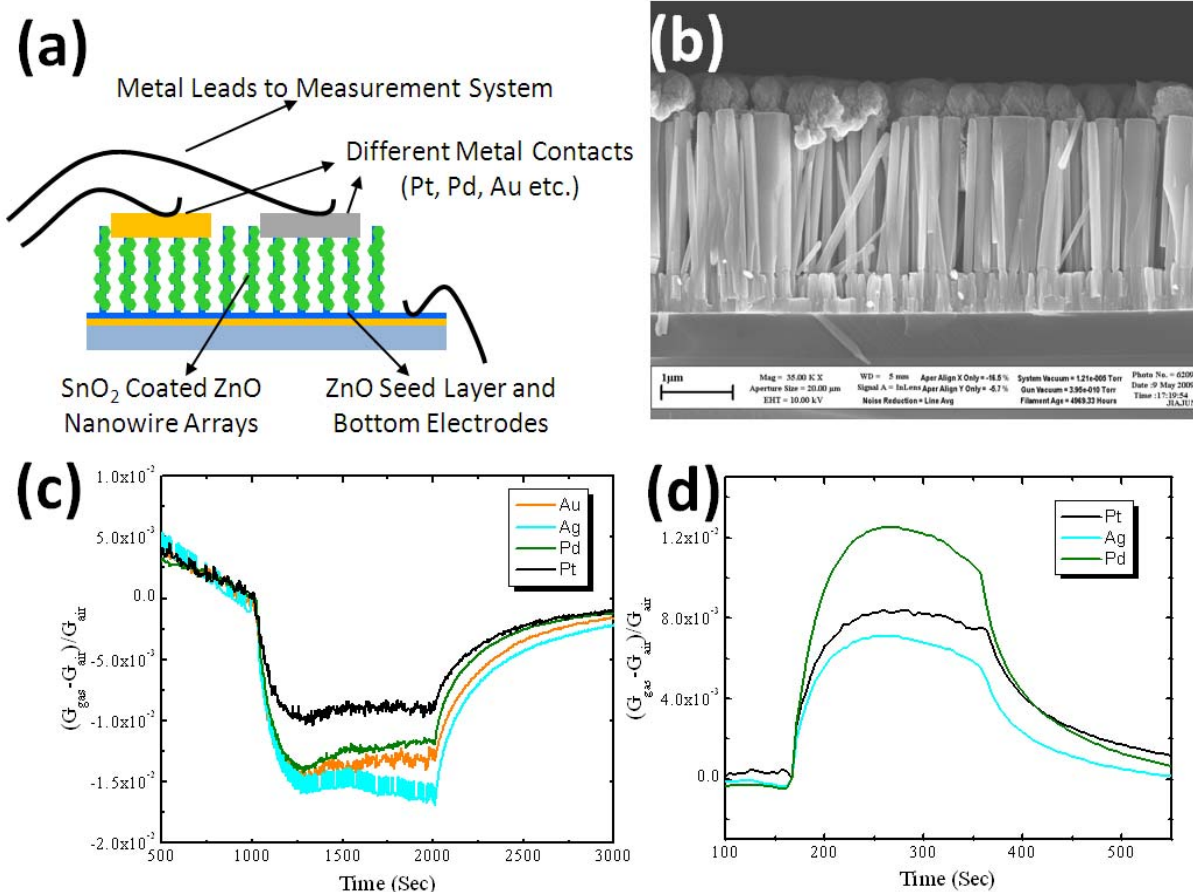


Figure 2 (a) Schematics showing the device structures prepared through conventional photolithography and (b) FESEM image of cross-section of as-prepared devices. (c) Device responses to 25 ppb NO₂ at room temperature. (d) Sensing responses to 500 ppb H₂S at room temperature.

REFERENCES:

- [1] G. Korotcenkov, Sens. Actuat. B 107(2005)209-232.
- [2] J. Y. Park, D. E. Song, and S. S. Kim, Nanotechnology 19(2008)105503.
- [3] K. Kalantar-zadeh and B. Fry, "Nanotechnology-Enabled Sensors", Springer, New York, 2007.
- [4] P. C. Jurs, G. A. Bakken, and H. E. McClelland, Chem. Rev. 100(2000)2649.
- [5] We thanks the support from the the DARPA Grant No.HR0011-07-1-0032 and research grants from Louisiana Board of Regents Contract Nos. LEQSF (2007-12)-ENH-PKSFI-PRS-04 and LEQSF (2008-11)-RD-B-10.

NANO APTASENSOR FOR PROTECTIVE ANTIGEN TOXIN

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ABSTRACT

Anthrax has become a most sought after bioweapon by anti-social elements and terrorist organizations in the recent times owing to its high mortality and environmental stability. In order to effectively combat this treat early detection of infection is necessary. Here, we report a successful demonstration of a highly sensitive nano aptasensor for anthrax toxin through the detection of its polypeptide entity, protective antigen (PA toxin), using PA toxin DNA aptamers functionalized single walled carbon nanotubes (SWCNTs) device. The aptamer was developed in house by capillary electrophoresis systematic evolution of ligands by exponential enrichment (CE-SELEX) and had a dissociation constant (K_d) of 890 nM. The nano aptasensor detected PA toxin sensitively (in concentration range of 1 nM to 1 μ M) and selectively (without interference from human and bovine serum albumin) making it a very useful diagnostic tool.

HIGH SPECTRAL RESOLUTION THz REFLECTIVE IMAGING BASED ON A TANDEM-BANDPASS FILTER

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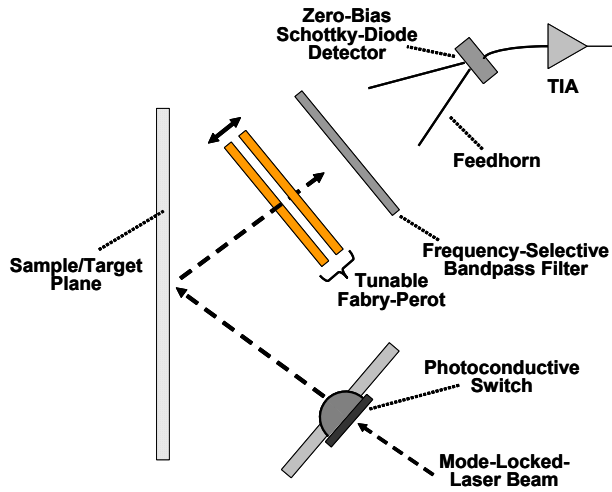
Abstract

The THz region continues to attract widespread interest because of its unique phenomenology for concealed-object, pharmaceutical, explosive-material, and biological spectroscopy and imaging. When driven by subpicosecond mode-locked lasers, ultrafast photoconductive switches are the most powerful solid-state sources in the THz region, and act as the foundation for several successful systems including time-domain spectrometers and impulse radars. A longstanding drawback with this source is that the power spectrum is widely spread in frequency, being a Dirac-comb at integral multiples of the pulse-repetition frequency, which is generally below 100 MHz. Time-domain systems rely on the pulse-to-pulse coherence, which allows acceptable resolution to be obtained after mixing the received signal against the same mode-locked laser pulse train and varying the time delay between the two, thereby providing the autocorrelation function. Impulse radars do not have this capability since, for simplicity, they utilize the mode-locked laser only in the transmitter, and design the receiver around a low-cost, high-speed Schottky diode, which loses the phase information. This paper addresses a novel method for achieving comparable if not superior resolution in an THz impulse imaging radar as commonly obtained in a time-domain system, and at a small fraction of the cost.

The trick is a new frequency-discriminating component for the THz region, a tandem bandpass filter (TBF), which combines a high-Q tunable Fabry-Perot with a low-Q metal-mesh bandpass filter, as shown in Fig. 1(a). The high-Q Fabry-Perot alone provides resolution down to approximately 1 GHz at $f_0 = 1$ THz center frequency, but also presents spectral ambiguity by passing radiation at the higher orders (i.e., half-integral multiples) of f_0 . To eliminate this ambiguity, we add a frequency-selective-surface (FSS) metal-mesh bandpass filter. While having much lower Q than the Fabry-Perot (and therefore lower resolution), it has no spectral ambiguity, and therefore blocks the higher-orders of f_0 . To the best of our knowledge, this is the first implementation of such a filter combination in the THz region. Demonstrations are underway, the first one being reflective spectroscopic imaging from organic and biomaterials having known strong THz signatures, such as lactose monohydrate. The results will be presented at the Conference.

Acknowledgements

This research was supported by the U.S. Army Research Office (Dr. D. L. Woolard) and by the U.S. Army Edgewood Chemical and Biological Command (Dr. Jim Jensen).



(a) Experimental Setup

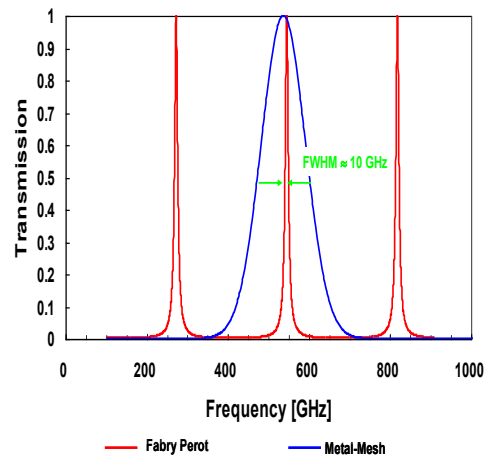


Figure 1
(b) Response of metal mesh filter and Fabry-Perot

PREPARATION OF 3-AMINOPROPYL-TRIETHOXYSILANE LINE PATTERN ON MICA FOR DNA ORIGAMI LOCALIZATION

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SUMMARY: The paper details the method of fabrication, characterization and application of 3-aminopropyl-triethoxysilane (APTES) line patterns prepared using soft lithography. The APTES system was chosen because the terminal amine group provides an electrostatic binding mechanism for localizing the highly negatively charged DNA origami constructs. Monolayer lines of AFTES with linewidths on the order of 200 nm have been produced.

Progress in molecular optoelectronic sensor development requires the production of nanostructures which control the orientation of molecular species. It is also important to develop methods for the stable, indexed localization of these nanostructures. Microcontact printing (μ CP) is an efficient method for producing patterns of self-assembled monolayers (SAM) containing different functional groups on a variety of surfaces [1]. We have adapted this approach to provide a rapid method for the production of SAM patterns on mica. Mica substrates are used extensively in scanning probe microscopy studies because mica has an extremely flat surface which is readily renewed using a cleaving process similar to that employed for graphite. Although mica has been used as a substrate for imaging biomolecules like DNA [2], protein [3], DNA-protein interaction [4] and DNA scaffolds [5] among others, these molecular samples are usually distributed randomly on the surface, with no control of spatial or angular distribution of the molecule of interest. We have developed a simple and convenient μ CP-based technique for the nano-patterning of APTES on mica substrates. 1.2micron and 830 nm blazed gratings have been used as molds in the production of soft PDMS stamps. These stamps have been used to prepare fine line patterns of APTES on flat mica surfaces. Figure 1a illustrates the process used to produce these APTES patterns on mica. The initial stamping process produces continuous linear features composed of multilayers of APTES, as evident in the AFM image reproduced in Figure 1b.

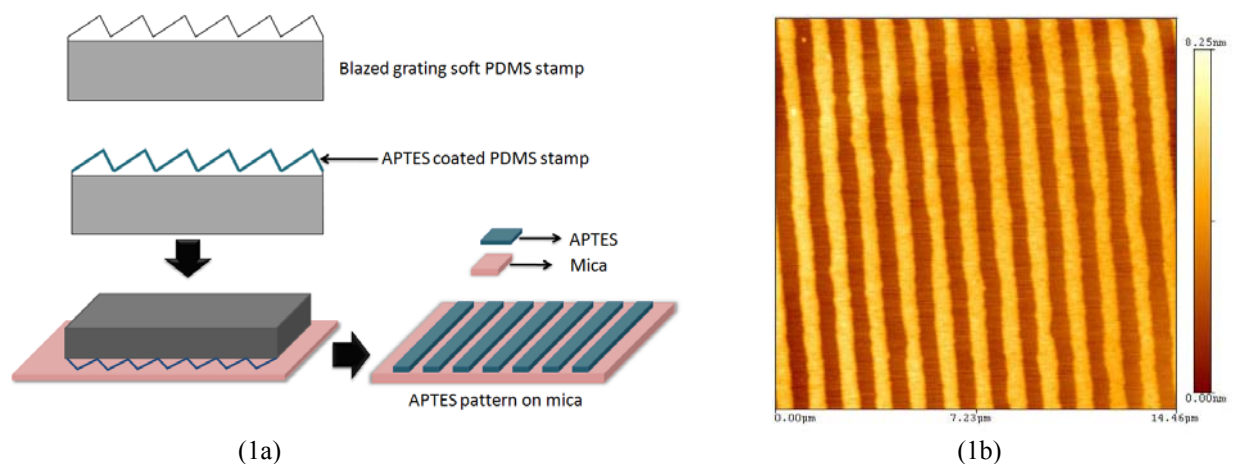


Figure 1: Schematic illustration of APTES patterning process using soft-PDMS (1a); AFM image of APTES linear feature on mica (1b).

The quality of the PDMS stamp and the pressure applied to the stamp during μ CP strongly influences the continuity and the thickness of the printed APTES line. APTES lines varying from 200~600nm in width are obtained under the conditions used. To remove excess APTES material which is not covalently bound to the mica, the line pattern is vigorously washed with ethanol. The patterned material has been characterized using AFM phase imaging. At surface coverages which provide minimal contrast in tapping mode AFM imaging, the phase imaging mode clearly indicates strong corrugation of the chemical composition of the modified mica surface. It is anticipated that the μ CP APTES pattern will provide an optimum nanoscale template for biomolecule patterning with reduced nonspecific binding provide the indexed localization required for significant progress in the field of DNA-based nanotechnology.

REFERENCES:

- [1] M. Mrksich, C. S. Chen, Y. Xia, L E Dike, D. E. Ingber, and G. M. Whitesides, (1996) *PNAS* vol. 93 no. 20, 10775-10778
- [2] Luda S. Shlyakhtenko, Alexander A. Gall, Jeffrey J. Weimer, David D. Hawn, and Yuri L. Lyubchenko, (1999) *Biophysical Journal*, vol. 77, 568-576
- [3] Hansma, H.G., Bezanilla, M., Laney,D.L., Sinsheimer, R.L. and Hansma, P.K. (1995) *Biophys. J.*, vol. 68, 1672-1677.
- [4] Wyman, C., Grotkopp, E., Bustamante, C. and Nelson, H.C.M. (1995) *EMBO J.*, vol. 14, 117-123.
- [5] Nadrian C. Seeman and Richard A. Kiehl, (2004) *Nano Lett.*, vol. 4, No. 12, 2343-2347

MAGNETIC/POLYANILINE CORE/SHELL NANOPARTICLES FOR TARGET EXTRACTION AND ELECTRICAL DETECTION OF THREAT-AGENTS

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SUMMARY: We present here a complete system for recovery, concentration, and detection of bacterial threat-agents (such as *Bacillus anthracis* spores) from food, environmental, or biological sources. Immunofunctionalized magnetic/polyaniline core/shell nanoparticles are employed to capture the bacterial target and magnetically isolate cells from the surrounding matrix [1]. Detection is performed by cyclic voltammetry on screen-printed carbon electrode (SPCE) sensors. The electroactivity of the core/shell nanoparticles (c/sNPs) allows current to flow between the screen-printed working and reference electrodes when a cycling potential is applied. The magnitude of the current response is significantly decreased by the presence of viable cells on the SPCE surface. Preliminary results, using *E. coli* O157:H7 to demonstrate proof-of-concept, show a detection limit less than 10^2 CFU/ml in pure culture ($<10^1$ cells per sensor). Total assay time from sample preparation to test result is about 80 minutes. Our paper will present the c/sNP system for directly extracting and detecting *Bacillus anthracis* spores in water and food matrices. *B. anthracis* is the highly-infectious causative agent of anthrax, a severe and often fatal disease taking on respiratory, gastrointestinal, and cutaneous forms in humans. *B. anthracis* spores can withstand harsh environments for long periods of time, and revert to a vegetative state when favorable conditions are encountered, making this organism an ideal agent for biological warfare. The National Institute of Allergy and Infectious Diseases consider *Bacillus anthracis* a priority pathogen in biodefense [2].

A schematic of the c/sNP synthesis and immunofunctionalization is shown in Figure 1. The γ -Fe₂O₃ nanoparticle core serves as a template for chemical polymerization of aniline, creating a polyaniline “shell” around the iron (III) oxide core (Figure 1A). The resulting nanoparticle possesses both the magnetic properties of its core and the electroactivity of its shell material. Finally the polyaniline shell surface is functionalized with antibodies by physical adsorption (Figure 1B), and the final product is isolated from excess antibody by magnetic separation.

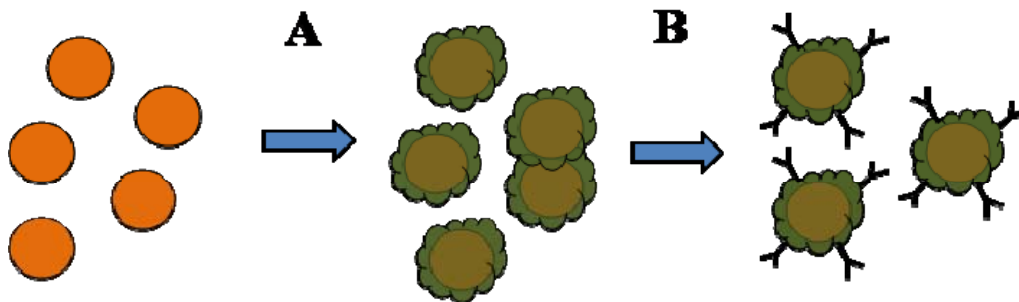


Figure 1. Synthesis and immunofunctionalization of c/sNPs: (A) polymerization of aniline over iron oxide core; (B) antibody adsorption onto polyaniline shell.

Figure 2 shows transmission electron microscope (TEM) images of the unmodified γ -Fe₂O₃ nanoparticle core (a) and the polyaniline-coated c/sNPs (b). Synthesized c/sNPs are approximately 30-50 nm in diameter, and size variation is due to non-uniform polymer coating. Aggregation is observed, so nanoparticles are dispersed by sonication prior to addition of antibodies.

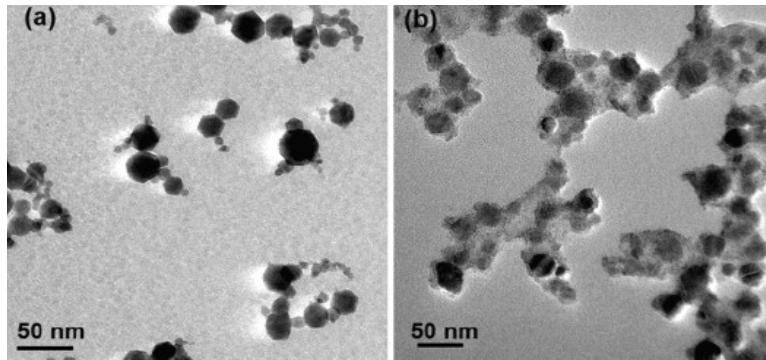


Figure 2. TEM images of (a) unmodified $\gamma\text{-Fe}_2\text{O}_3$ nanoparticles and (b) magnetic/polyaniline c/sNPs.

A schematic of the target extraction technique is shown in Figure 3. Immunofunctionalized c/sNPs are added to a heterogeneous liquid sample (e.g., microbial growth media, food puree, environmental water, etc.) and allowed to hybridize with target cells in the sample. When a magnetic field is applied to the sample, the c/sNP-target complex is held in place while surrounding fluid and particles are removed. The isolated c/sNP-target is washed several times and resuspended in acidic solution to re-dope the polyaniline shell before deposition onto the SPCE sensor and electrochemical detection.

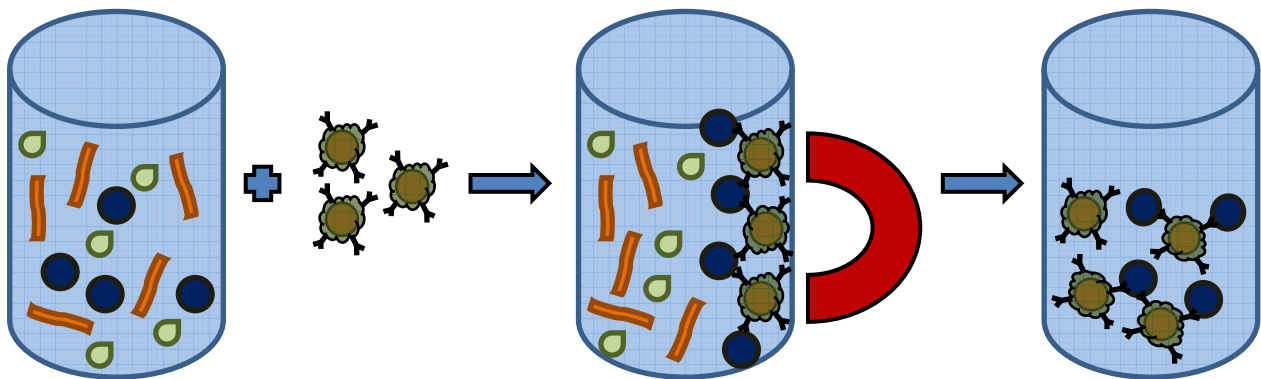


Figure 3. Heterogeneous sample + c/sNPs \rightarrow Magnetic separation of target cells \rightarrow Concentrated target.

REFERENCES

- [1] Pal, S., Settingington, E., and Alocilja, E.C. 2008. Electrically-Active Magnetic Nanoparticles for Concentrating and Detecting *Bacillus anthracis* Spores in a Direct-Charge Transfer Biosensor. *IEEE Sensors Journal* 8(6): 647-654.
- [2] NIH (National Institutes of Health). 2008. Biodefense: NIAID Category A, B, and C Priority Pathogens. National Institute of Allergy and Infectious Diseases. Accessed 29 June 2009.

CHARACTERIZATION AND FUNCTIONALIZATION OF BIOGENIC GOLD NANOPARTICLES FOR BIOSENSING ENHANCEMENT

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SUMMARY:

The unique tunable physicochemical properties of AuNPs, plus their excellent biological compatibility, conducting properties, and high surface-to-volume ratio make them ideal candidates for electronic signal transduction of biological recognition events in biosensing platforms. Commonly, AuNPs are synthesized by chemical reduction of HAuCl_4 and the introduction of a protective agent (stabilizer). In the last few years, alternative biosynthetic approaches have been explored using microorganisms as bio-nano-factories to produce metal nanoparticles. AuNP biosynthesis procedures include the use of fungi and bacteria strains. In the present study, the alkalothermophilic actinomycete *Thermomonospora curvata* (ATCC 19995) was used for the extracellular aerobic biosynthesis of gold nanoparticles (AuNP) [1]. Optimal growth and biosynthesis conditions were established. The average AuNP size obtained was in the range of 30-50 nm (Fig. 1). The monodisperse and water soluble AuNPs were characterized and functionalized with different protective agents for the immobilization of biological recognition agents (e.g. antibodies and DNA probes). Additionally, the biogenic AuNPs were compared with the chemically synthesized AuNPs. The green-chemistry AuNPs obtained in this study can be used to enhance biosensing applications; as transducers or electroactive labels, especially in nanoparticle based electrochemical DNA detection systems.

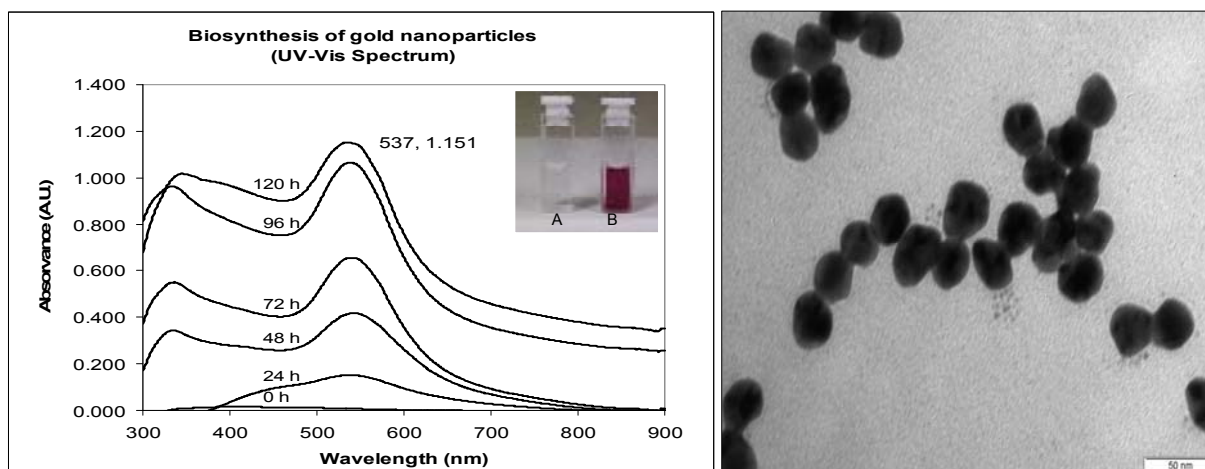


Figure 1. Left image: UV-Vis spectra of AuNP production using *T. curvata* biomass and a 1mM solution of HAuCl_4 . The absorption peak at 537 nm is due to the surface plasmon resonance band of AuNPs. The wavelength is consistent with AuNPs having 30-50 nm in diameter. Inset: A) HAuCl_4 solution before the synthesis; B) AuNPs solution after 5 days of incubation. Right image: TEM images of AuNPs after 5 days of incubation. The average diameter is 30-50 nm.

REFERENCES

[1] Ahmad A, Senapati S, Khan MI, Kumar R, Sastry M. Extracellular biosynthesis of monodisperse gold nanoparticles by a novel extremophilic actinomycete, *Thermomonospora* sp. *Langmuir* 2003; 19:3550-3.