10-23-2008

Request for Graduate Travel Support to Attend the Nanoelectronic Devices for Defense $ Security (NANO-DDS) Conference 2007. To be held June 18-21, 2007 in Crystal City Arlington

Carl P. Tripp
Principal Investigator; University of Maine, Orono, ctripp@maine.edu

Final Report for Period: 07/2007 - 06/2008 **Submitted on:** 10/23/2008

Principal Investigator: Tripp, Carl P. **Award ID:** 0738826

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 2007. To be held June 18-21, 2007 in Crystal City Arlington,

Project Participants

Senior Personnel

Name: Tripp, Carl

Worked for more than 160 Hours: Yes

Contribution to Project:

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Other Collaborators or Contacts

Activities and Findings

Research and Education Activities:

see attached file

Findings:

see attached file

Training and Development:

see attached file

Outreach Activities:

see attached file

Journal Publications

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Contributions

Categories for which nothing is reported:

Organizational Partners
Any Journal
Any Book
Any Web/Internet Site
Any Product
Any Contribution

The University of Maine provided supported to five student attendees at the 2007 Nanoelectronics Devices for Defense & Security (NANO-DDS) Conference. The students that received support in attending the 2007 NANO-DDS Conference were:

Mr. Greg Andreev from the University of California-San Diego
Mr. Samuel Dickerson from the University of Pittsburgh (Student from a minority group)
Mr. Simon Ghionea from Oregon State University
Mr. Robert Johnson from the University of Pennsylvania
Mr. Alexander Kuznetsov from the University of Texas-Dallas

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. The amount allocated to each student is given in a spreadsheet attached to this report.

All of the supported students participated in the technical program of the conference. Specifically four of the students gave platform presentations and one gave a poster presentation. The sessions in which the students participated are given on the spreadsheet in the second attachment, and the associated abstracts 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.

2007 Nanoelectronic Devices for Defense & Security
18-21 June, 2007, Arlington Virginia

Greg Andreev
University of California-San Diego
Email: gandreev@ucsd.edu

Dear Mr. Andreev,

The organizers of the 2007 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to be able to offer you support for attending the 2007 NANO-DDS Conference during the week of 18-21 June, 2007 in Arlington, Virginia. Specifically, you will be allowed the following Attendee-Assistance support:

(1) Waiver of the Full Conference Registration Fee ($565.00 will be paid on your behalf)
(2) An Allowance of up to $300.00 towards Travel to/from the Conference.
(3) An Allowance of up to $200.00 towards accommodations in the Arlington, Virginia area during the week of 17-21 June, 2007.

If you would like to accept this offer of Attendee-Assistance support please send an email to admin@nano-dds.com indicating your intention of attending the 2007 NANO-DDS Conference.

IMPORTANT NOTE: To obtain the financial reimbursements listed in (2) and (3) above the Conference Attendee must submit the attached Travel-Assistance Form (i.e., NANO-DDS-07-TAF) and all associated receipts after attending the conference. It will also be necessary to follow all the instructions that are included on the NANO-DDS-07-TAF form in completing and submitting the form and substantiating receipts 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 2007 NANO-DDS Conference would like to recognize the National Science Foundation (NSF) and the University of Maine for sponsoring your travel.

Best Regards

Dr. Hong-Liang Cui
2007 NANO-DDS
Conference Manager

2007 Nanoelectronic Devices for Defense & Security
18-21 June, 2007, Arlington Virginia

Samuel Dickerson
University of Pittsburgh
Email: sjdst31@pitt.edu

Dear Mr. Dickerson,

The organizers of the 2007 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to be able to offer you support for attending the 2007 NANO-DDS Conference during the week of 18-21 June, 2007 in Arlington, Virginia. Specifically, you will be allowed the following Attendee-Assistance support:

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Best Regards

Dr. Hong-Liang Cui
2007 NANO-DDS
Conference Manager

2007 Nanoelectronic Devices for Defense & Security
18-21 June, 2007, Arlington Virginia

Simon Ghionea
Oregon State University
Email: ghioneas@engr.orst.edu

Dear Mr. Ghionea,

The organizers of the 2007 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to be able to offer you support for attending the 2007 NANO-DDS Conference during the week of 18-21 June, 2007 in Arlington, Virginia. Specifically, you will be allowed the following Attendee-Assistance support:

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Dr. Hong-Liang Cui
2007 NANO-DDS
Conference Manager

2007 Nanoelectronic Devices for Defense & Security
18-21 June, 2007, Arlington Virginia

Robert Johnson
University of Pennsylvania
Email: robertjo@physics.upenn.edu

Dear Mr. Johnson,

The organizers of the 2007 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to be able to offer you support for attending the 2007 NANO-DDS Conference during the week of 18-21 June, 2007 in Arlington, Virginia. Specifically, you will be allowed the following Attendee-Assistance support:

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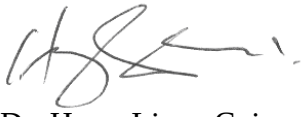
Best Regards



Dr. Hong-Liang Cui
2007 NANO-DDS
Conference Manager

2007 Nanoelectronic Devices for Defense & Security
18-21 June, 2007, Arlington Virginia

Alexander Kuznetsov
University of Texas-Dallas
Email: aak036000@utdallas.edu

Dear Mr. Kuznetsov,

The organizers of the 2007 Nanoelectronic Devices for Defense & Security (NANO-DDS) Conference are pleased to be able to offer you support for attending the 2007 NANO-DDS Conference during the week of 18-21 June, 2007 in Arlington, Virginia. Specifically, you will be allowed the following Attendee-Assistance support:

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Best Regards

Dr. Hong-Liang Cui
2007 NANO-DDS
Conference Manager

Budget

STUDENT	MINORITY	EMAIL	REG	TRAVEL	HOTEL	TOTAL	ABSTRACT	PRESENTATION
yes	yes	sjdst31@pitt.edu	565	500	400	1465	224	Session I-A Monday 6/18
yes	no	gandreev@ucsd.edu	565	300	200	1065	203	Session II-B1 Tuesday 6/19
yes	no	robertjo@physics.upenn.edu	565	130	400	1095	106	Session III-C2 Wednesday 6/20
yes	no	aak036000@utdallas.edu	565	300	300	1165	72	Poster Session I Monday 6/18
yes	no	ghioneas@engr.orst.edu	565	500	400	1465	200	Session II-B1 Tuesday 6/19
			2825	1730	1700	6255		

QUANTUM DOTS IN 1D PHOTONIC CRYSTALS: PATHWAY TO TERAHERTZ LASING

Alexander Kuznetsov[1], Joshua Rouse[1], Sean Anderson[2],
Sergei Krivoshlykov[3], Philippe Fauchet[2], Anvar Zakhidov[1], Valery Rupasov[3]

[1]Nanotech Institute, University of Texas at Dallas, Richardson, Texas 75080-1407
[2]University of Rochester, Rochester, NY 14627
[3]ALTAIR Center, LLC, 1 Chartwel Cir., Shrewsbury, MA 01545

ABSTRACT

Theoretical estimates and absorption experiments [1] show that colloidal semiconductor nanocrystal quantum dots exhibit strong intraband optical transitions in both conduction and valence bands. In PbSe quantum dots of sufficiently large diameter the wavelength of $1P_{h(e)}$-$1S_{h(e)}$ intraband transition in both conduction and valence bands can be greater than 10 microns. Due to "mirror symmetry" of the conduction and valence bands in PbSe material having equal effective masses ($m_e=m_h$), an optical pump of the intraband $1P_{h(e)}$-$1S_{h(e)}$ transitions simultaneously in the conduction and valence bands can be achieved by near-infrared laser light resonant with the interband $1P_h$–$1P_e$ optical transition. However, because of fast nonradiative (phonon) relaxation of intraband optical transitions their possible use as long-wave-infrared and terahertz light sources is not straightforward.

One of possible pathways overcoming the drawback of fast nonradiative relaxation is an essential enhancement of optical pump. To enhance optical pumping level of interband $1P_h$-$1P_e$ transition, we infiltrate PbSe quantum dots into one-dimensional photonic crystal having a bandgap around the wavelength of $1P_h$-$1P_e$ transition and a "defect" mode, which is resonant with $1P_h$-$1P_e$ transition. The photonic crystal is a periodic structure made of porous silicon layers of different porosity [2]. Such a 1D photonic crystal with the defect mode plays a role of an optical cavity for pump light while for the light generated on the intraband transitions $1P_e$-$1S_e$ an external optical cavity is used. Moreover, organic ligands, which essentially contribute to fast phonon relaxation in colloidal quantum dots [3], can now be completely removed, because porous structure prevents a conglomeration of quantum dots, so quantum dots don't need ligand caps.

Finally, we discuss an electromagnetic enhancement of intraband optical transitions due to their coupling to surface plasmons in core-shell semiconductor quantum dots [4].

The work is supported by Army STTR Contract W911NF-05-C-0124.

REFERENCES

[1] P. Guyot-Sionnest and M. A. Hines, Appl. Phys. Lett. **72**, 686 (1998).
[2] S. M. Weiss and P. M. Fauchet, Silicon-based and Hybrid Optoelectronics, Proc. of SPIE **4654**, 36 (2002).
[3] P. Guyot-Sionnest, B. Wehrenberg, and Dong Yu, J. Chem. Phys. **123**, 074709 (2005).
[4] V. I. Rupasov, Phys. Lett. A **363**, 140-149; 154-158 (2007).

PROBING THE STRUCTURE OF DNA-CARBON NANOTUBE HYBRIDS WITH MOLECULAR DYNAMICS

Robert R. Johnson[1], A.T. Charlie Johnson[1], Michael L. Klein[2]

[1] Department of Physics and Astronomy, University of Pennsylvania, Philadelphia, PA 19104
[2] Department of Chemistry, University of Pennsylvania, Philadelphia, PA 19104

ABSTRACT

DNA-carbon nanotube hybrids (DNA-NT) are novel nanoscale materials that consist of single walled carbon nanotubes (SWNT) coated with a self-assembled monolayer of single stranded DNA (ssDNA) (Figure 1). Many recent experiments involving DNA-NT have shown that this material is an excellent candidate for chemical [1-2] and biological [3] sensing applications. Despite the significance of DNA-NT, a detailed understanding of its microscopic structure and interactions is lacking. Such properties are of utmost importance in order to rationalize improvements on chemical/biological sensing devices composed of this nanomaterial. To address these issues we have performed classical all-atom molecular dynamics (MD) simulations using empirical force fields. MD reveals the nature of the interactions and structural arrangements involved in DNA-NT. We find that the hybrid material spontaneously self-assembles in aqueous solution via the π-π stacking interaction between ssDNA nucleobases and SWNT outer wall. As a result, ssDNA's negatively charged sugar-phosphate backbone is exposed to the environment and can strongly interact with water and other polar molecules. Under ambient conditions, ssDNA can adopt various wrapping conformations about SWNT including right- and left-handed helices as well as disordered, kinked structures. Helical wrapping is driven by asymmetric torsional forces in the sugar-phosphate backbone that result in ssDNA wrapping from the 3' end to the 5' end. Additionally, energetic analysis of the equilibrated structures reveals that DNA-NT assembles with a preferred orientation of the ssDNA backbone relative to SWNT.

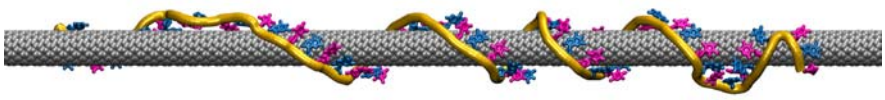

Figure 1: DNA-Carbon nanotube hybrid. ssDNA conformation obtained from MD simulation.

REFERENCES

[1] Staii, C.; Chen, M.; Gelperin, A.; Johnson, A.T. Nano Lett., 2005, 5, 1774-1778.
[2] Johnson, A.T.; Staii, C.; Chen, M.; Khamis, S.; Johnson, R.R.; Gelperin, A.; Klein, M.L. Semicond. Sci. Technol., 2006, 21, S17-S21.
[3] Star, C.; Tu, E.; Niemann, J.; Gabriel, J.C.P.; Joiner, C.S.; Valcke, C. PNAS, 2006, 103, 921-926.

FERROMAGNETIC RESONANCE DETECTION FOR MAGNETIC MICROBEAD SENSORS

Simon Ghionea, Pallavi Dhagat, Albrecht Jander

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ABSTRACT

Sensors based on magnetic micro-bead labeling can be used to detect a variety of biological and chemical agents. Applications range from counterterrorism monitoring to bio-medical diagnostics. The functionalized micro-beads attach to target molecules via biomolecular reactions and are then flowed through microfluidic channels to the sensitive region of the detector. This region is bio-chemically activated so that beads bound to the target molecules are immobilized in a sandwich assay and can then be detected.

We are developing a detector to sense the presence of magnetic micro-beads with ultra high sensitivity using ferromagnetic resonance (FMR). Our approach employs two planar microwave waveguide structures (coplanar waveguide and a slotline) with orthogonal propagation modes (Fig. 1). The waveguides are terminated together at a short circuited junction which serves as the sensor area. In the absence of immobilized beads at the junction, no signal couples from the slotline into the output at the coplanar waveguide. However, when a bead is present at the junction, an orthogonal magnetic field component is induced coupling the signal from the slotline to the coplanar waveguide. This coupled signal is enhanced by exciting ferromagnetic resonance in the bead using an applied DC bias magnetic field. Similar waveguide devices have been previously used for FMR experiments on thin magnetic film dots [1, 2].

In contrast to alternative magnetic bead detection techniques using giant magnetoresistive (GMR) or Hall effect sensors, our detector does not require expensive processing of specialty thin films. Additionally, it is easily integrated with the required electronic circuitry using standard integrated circuit (IC) technology.

The waveguide response was simulated with and without a magnetic bead using Ansoft HFSS software. Dimensions and magnetic characteristics of commercially available M-450 Dynalbeads from Invitrogen were used. Initial results show a 0.15 dB increase in the signal coupled to the output due to the presence of a *single* bead (Fig. 2). The coupled signal or detector sensitivity can be further improved by optimizing the bead properties and waveguide junction geometry.

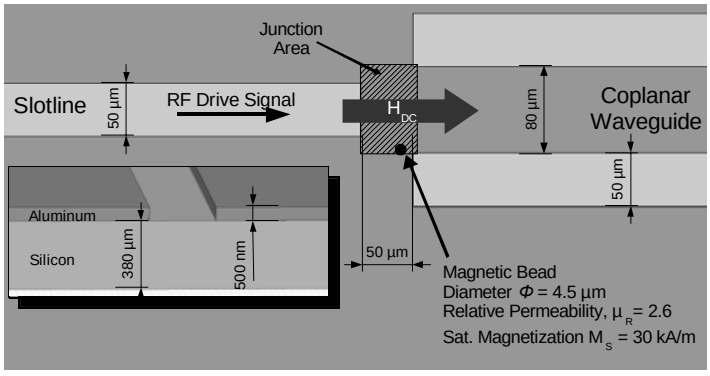

Fig. 1. Schematic of FMR Detector

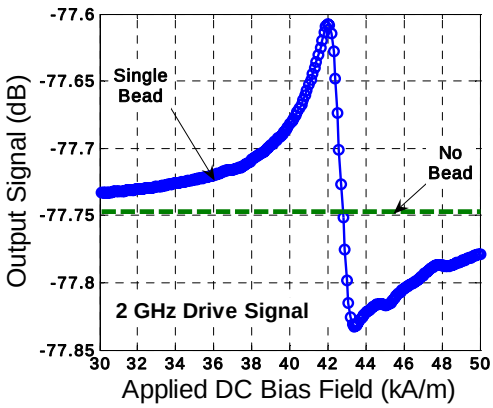

Fig. 2. Response For a Single Bead

REFERENCES

[1] Dotsch, H., Schmitt, H.J., and Muller, J., *Appl. Phys. Lett.*, 23, 639-641, 1973.
[2] Zhang, S., Oliver, A., Israeloff, N.E., Widom, A., and Vittoria, C., *J. Appl. Phys.*, 81, 4307-4309, 1997.

NEAR FIELD THZ SENSOR BASED ON METAMATERIALS

G.O. Andreev*[1], T. Driscoll[1]*, S.Palit[2], S.Y. Cho[2], N.M. Jokerst[2], D.R. Smith[2], M. di Ventra[1], D. N. Basov[1]

*These two authors contributed equally to this work

[1] University of California San Diego, Department of Physics, La Jolla, CA 92093

[2] Duke University, Department of Electrical and Computer Engineering, Durham, NC 27708

ABSTRACT

We will discuss novel approaches employing near fields to detect minute concentrations of both organic and inorganic substances by monitoring their optical constants in the THz range. A novel sensor is presented employing the near field sensitivity of a THz Split-Ring Resonator (SRR) array to nanoscale objects in the rings. In Fig. 1 we show our device geometry of SRR's on a silicon substrate. The sensor concept is to tune the capacitance by adding a dielectric material in the gap of the split ring. A change in capacitance alters the resonance frequency of the SRR according to $\omega_0 = \frac{1}{\sqrt{LC}}$ where the inductance, L, stems from the ring, and the capacitance, C, is due to the two plates present in the split in the ring. An additional feature of the device is the ~10X concentration of the incident field in the gap region which has been confirmed experimentally and in simulations, the results of which are shown in Fig. 1c. These factors make the device sensitive to objects only in the gap region. We would also like to note that the device we use has a resonance in the THz region, where λ≈300 μm, which is much bigger than the size of the capacitor gap ~3 μm. Therefore the fields in the gap regin are inherently near fields so we have the unique opportunity to probe organic and inorganic materials much smaller than the incident wavelength. To demonstrate this we performed a proof of principle experiment where drops of 50nm silicon nanocrystal solution applied to the SRR array (Fig. 1b) tune the resonant frequency by as much as 10%, from 1.2 THz to 1.1 THz. The same quantity of material added to a bare substrate showed no change in transmission, corroborating the enhanced sensitivity of the device. Although we demonstrate the effectiveness of this sensor in Terahertz, the general idea is applicable to a wide array of metamaterials having resonances across the spectrum from microwave to visible. We also discuss the complementary nature of this sensor to existing near field approaches, specifically the scattering SNOM.

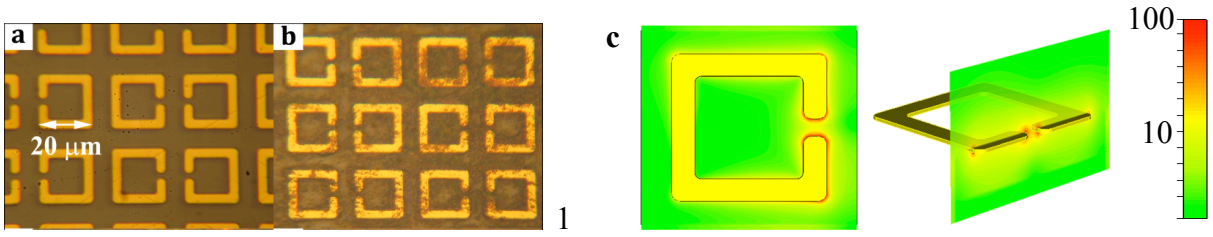

Figure 1. SRR sensor before and after application of Si Nanocrystals (a,b) Enhanced fields present in gap region, normalized to incident field (c).

REFERENCES

[1] T.Driscoll, G.O. Andreev, S.Palit, D.N. Basov, D.R. Smith – Applied Physics Letters (submitted 2007)

A 3D Integrated Circuit for Sensing Biological Nanoparticles

Samuel J. Dickerson[1], Arnaldo J. Noyola[1], Steven P. Levitan[1] and Donald M. Chiarulli[2]

University of Pittsburgh, Pittsburgh, PA
[1] Department of Electrical and Computer Engineering
[2] Department of Computer Science

ABSTRACT

We have designed a dielectrophoresis-based lab-on-chip using MIT Lincoln Labs 0.18 µm 3D integrated circuit technology. Dielectrophoresis is the phenomena where electric fields are used to control the movement of particles in a fluid. The topmost tier of a three chip stack (figure 1) is used to create a microfluidic trench and dielectrophoresis electrode array. During the 3D fabrication process, the top chip tier is assembled upside down and the substrate material is removed, putting the polysilicon layer in close proximity to the outside surface. We used use this layer to create an array of 2,048 electrodes, each being 180 nm wide and 200 µm long with a gap spacing of 270 nm between electrodes. A microfluidic trench is created directly above the electrode array by designating a large region as an electrical contact pad and etching away the top-level metal. This technique allows for very dense electrode arrays and avoids the need for cumbersome post-processing steps to create on-chip microfluidic channels. The remaining two chip tiers are used for electronics. Each electrode is driven by analog circuitry on the middle chip tier and the bottom tier is used for logic to control the waveform on each electrode.

Since individual nanoparticles are below the diffraction limit of conventional microscopes, detecting them on lab-on-chip devices is difficult. Additionally, in the case of analyzing living organisms, having to alter their biochemistry in order to detect them (e.g. fluorescence) is undesirable. Our approach is to use dielectrophoresis to arrange an ensemble of particles into periodic striped patterns that form a diffraction grating (figure 2) and measure its diffraction efficiency to sense the presence of particles. Particle-based gratings are created by programming the lab-on-chip to produce a pattern of alternating electric field maxima and minima. Particles in the solution will be attracted to the locations of the electric field peaks. Once the particles reach a steady-state, the resulting particle-grating will periodically modulate the index of refraction along the bottom surface of the microfluidic trench. The diffraction efficiency of this grating can be measured by using monochromatic incident light to observe the intensity of the reflected diffraction orders. A straightforward detection scheme that can be realized using this technique is a simple determination of whether or not particles are present in the sample under test. Since the periodicity of trapped particles (d) is programmable, the observation angle (θ) at which to expect diffracted orders for a given incident wavelength (λ) can be predetermined. Therefore, the discrete diffraction order (m), where $m\lambda = d(\sin\theta + \sin\beta)$, will only exist when particles are present in the sample. A more sophisticated analysis of the sample can be performed by creating a mapping between the magnitude of the diffracted orders and the physical dimensions of the particles (figure 3). This technique is especially well suited for biological particles because it does not require their natural optical properties to be artificially modified.

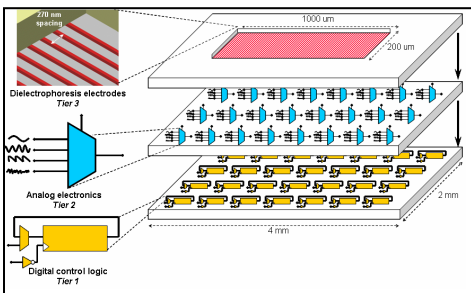

Figure 1 Organization of 3D lab-on-chip

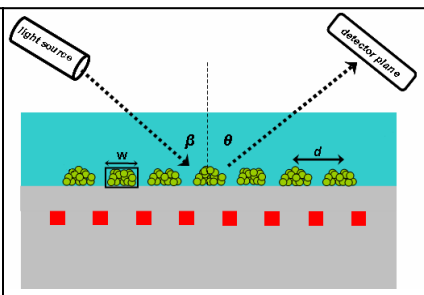

Figure 2 Nanoparticles arranged by dielectrophoresis to form a diffraction grating

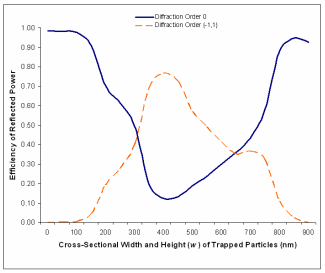

Figure 3 Efficiency of reflected diffraction orders versus cross-sectional area of trapped regions