Program on Nanotechnology Research and Innovation System Assessment
Georgia Institute of Technology

Nanotechnology R&D Profiles: Indian Publications

Pratik Mehta
Georgia Tech Technology Policy and Assessment Center
Georgia Institute of Technology
Atlanta, GA 30332-0345, USA

Email: pratik.99@gmail.com

December 5, 2007

This research was undertaken at Georgia Tech with support by the Center for Nanotechnology in Society at Arizona State University (CNS-ASU), funded by the National Science Foundation (Award No. 0531194). The findings and observations contained in this paper are those of the author and do not necessarily reflect the views of the National Science Foundation.

The information presented in this profile is based on a search of publication records (Science Citation Index, Web of Science, Thomson Scientific).[1] These records are cleaned and analyzed using VantagePoint textmining software.[2] In this document, nanotechnology is abbreviated as nano. Further details of the nano search strategy for developing the dataset are contained in Porter et al.[3] For more information, contact:

Professor Philip Shapira, Director
Program on Nanotechnology Research and Innovation Systems Assessment
Technology Policy and Assessment Center
Georgia Institute of Technology
Atlanta, GA 30332-0345, USA
http://www.nanopolicy.gatech.edu
Email: pshapira@gatech.edu

CNS - Center for Nanotechnology in Society at ASU
College of Liberal Arts and Sciences
PO Box 874401, Tempe AZ 85287-4401, USA
http://cns.asu.edu

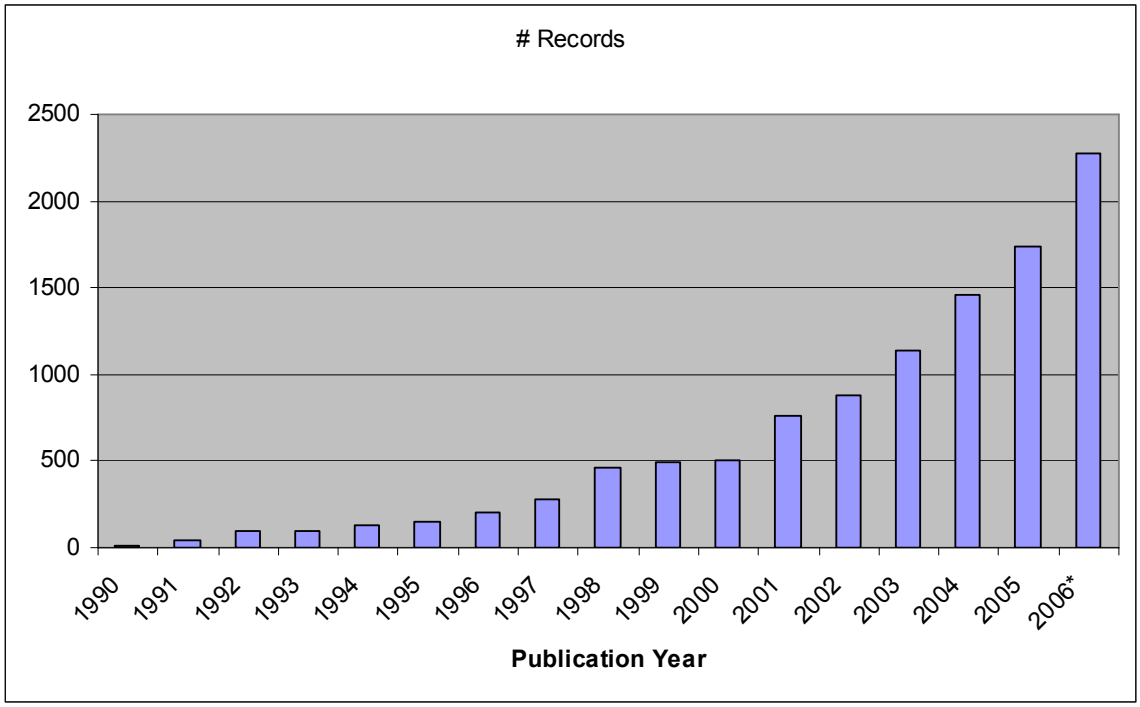
This report was prepared for Professor G. Ramanath, Rensselaer Polytechnic Institute, Troy, NY 12180, USA, coordinator of the US-India Nanoscience and Engineering Institute (USINSEI), January 9-18, 2008, Chennai, India.

[1] http://scientific.thomson.com/products/wos/
[2] http://www.thevantagepoint.com/
[3] More information on the search strategy on which the information presented herein is based can be found in Porter, A.L., Youtie, J., Shapira, P., and Schoeneck, D.J., Refining Search Terms for Nanotechnology, Journal of Nanoparticle Research (First Online, 2007).

Publications Trends (1990-2006*)

The figure shows the number of nano publications by India annually. The analysis is based on a Vantage Point data subset of SCI nanotechnology publications covering the period 1990-2006* (*mid-year) where an author affiliation is based in India (country field = "India").

Figure 1. Indian Nano Publications Trend (WOS)



Source: Georgia Tech nano-publication database (WoS), 1990-2006*, using nano definition in Porter et al., 2007. *Publications for 2006 are estimated based on half-year.

There is a steadily increasing trend in nano publications associated with Indian authors since 1990, with an increase in the trend since 2001.

International Comparison

The following table compares the number of publications by selected countries

Table1. Comparison of Nano Publications (WOS), 1990-2006*

Country	Publications	Publications / $ billion GDP	Publications / million population
USA	105068	9.1	350.5
Japan	47894	9.2	374.5
China	43785	21.1	33.9
Germany	38709	19.2	468.1
UK	22661	13.7	376.4
South Korea	15269	22.7	318.8
India	9399	13.8	8.3
Taiwan	7850	20.8	344.3
Singapore	4350	37.6	1011.6

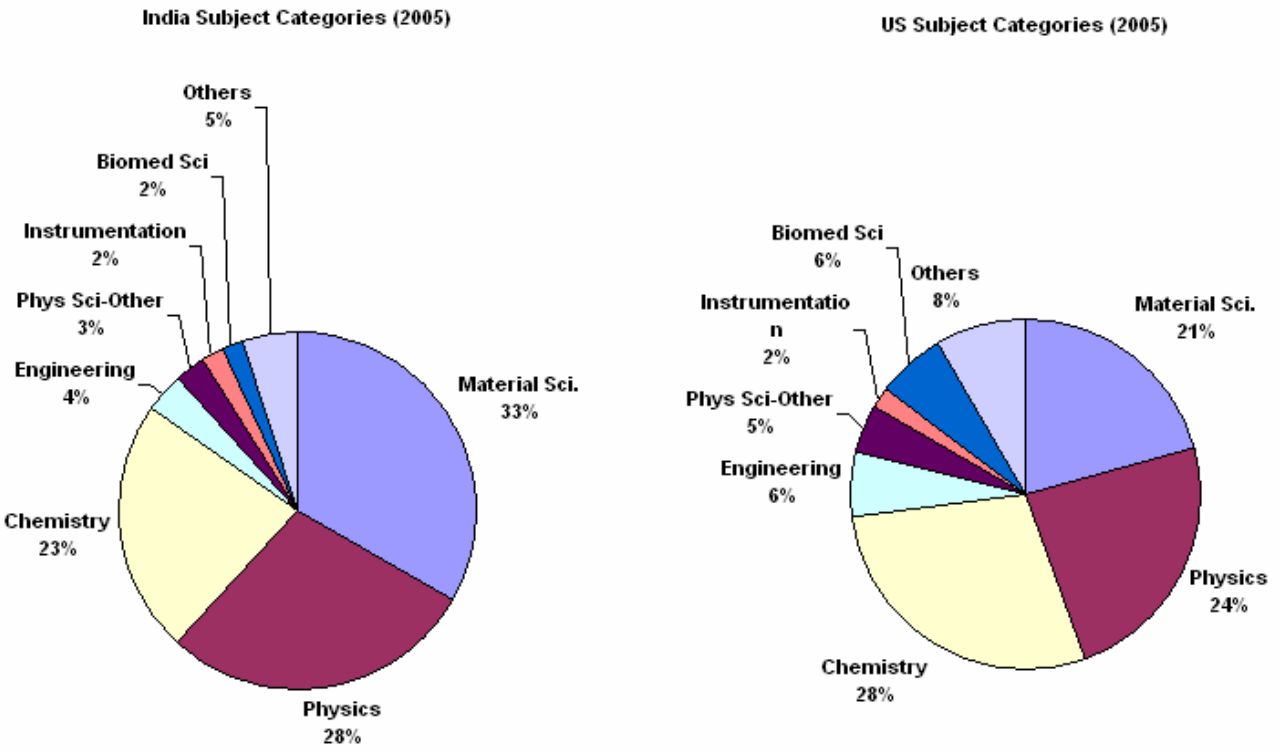
Source: Georgia Tech nano-publication database (WoS), 1990-2006*, using nano definition in Porter et al., 2007. *Publications for 2006 are estimated based on half-year. GDP (Gross Domestic Product) and population data for 2006 from United Nations Development Programme, Human Development Report online data. Taiwan GPD and population data calculated separately.

The US leads other countries in nano publications on an absolute basis. It has 11 times the number of publications of India but its GDP is also 17 times higher. Singapore has the highest number of publications per unit of GDP and per million people. China has a significantly higher level of publication activity, publications per GDP, and publications per million population than India.

Subject Category Comparison

The pie charts illustrate the subject categories of nano publications in India and US for 2005. We apply a thesaurus to the journal subject category field of to convert the numerous categories to the major summary categories shown below.

Figure 2. Nano Publications: Journal Subject Category Composition, India and the US

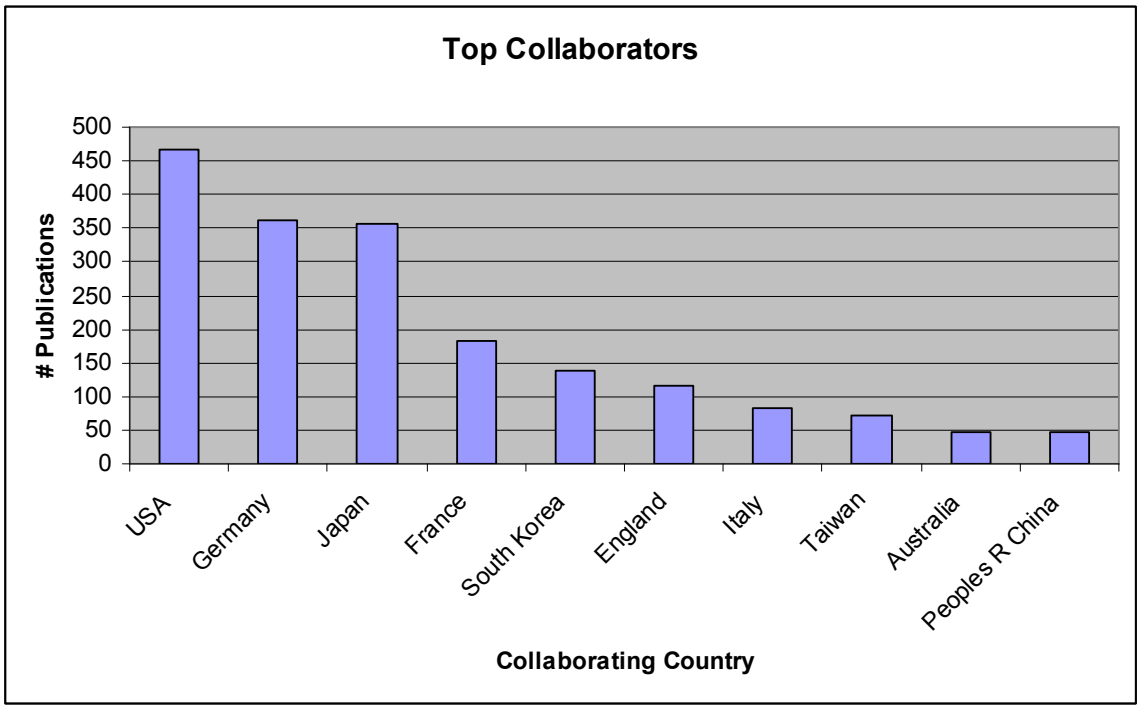


US nano publications are more focused on chemistry whereas India is more focused on materials science publications, by subject. (The focus on nano materials science is also seen in China.) Although still small in total, nano publications with a biomedical subject orientation are proportionally more significant in the US than in India.

Collaborations

The chart below shows the top countries collaborating with India for nano publications., based on author affiliations. The analysis is based on a Vantage Point data subset of Indian SCI nanotechnology publications covering the period 1990-2006* (*mid-year), with matrix of collaborators between India and other countries. The top 10 collaborators with India are shown.

Figure 3. Top Collaborating Countries with India (By Author Affiliation)



India's biggest collaborator in nano publication is the US, followed by Germany and Japan.

Top Affiliations (Leading Nano Publishing Institutions)

The following table gives the top affiliations for Indian nano publications. The profile also gives the top 5 Subject Categories and collaborating countries for these affiliations. We obtain these results by running a super profile macro on the affiliation field and further adding the subject category and country field.

Table 2. A Profile of the leading Indian Affiliations

#	Affiliation	Publication Year	Subject Category	Author Collaborating Countries
		% since 2004	Top 5 Items	Top 5 Items
1788	Indian Inst Technol	45% of 1788	Materials Science, Multidisciplinary [616]; Physics, Applied [314]; Physics, Condensed Matter [299]; Chemistry, Physical [234]; Polymer Science [187]	Germany [100]; USA [88]; Japan [61]; England [21]
807	Indian Inst Sci	35% of 807	Materials Science, Multidisciplinary [270]; Chemistry, Physical [159]; Physics, Condensed Matter [144]; Physics, Applied [100]; Chemistry, Multidisciplinary [79]	USA [61]; Japan [30]; France [24]; Israel [10]; England [10]; Germany [10]
669	Natl Chem Lab	45% of 669	Materials Science, Multidisciplinary [227]; Chemistry, Physical [226]; Physics, Applied [103]; Chemistry, Multidisciplinary [60]; Polymer Science [58]	France [22]; USA [17]; Germany [9]; Australia [6]
483	Indian Assoc Cultivat Sci	43% of 483	Materials Science, Multidisciplinary [160]; Physics, Applied [134]; Physics, Condensed Matter [97]; Chemistry, Physical [61]; Chemistry, Multidisciplinary [37]	Japan [25]; England [18]; Taiwan [11]; USA [11]; France [11]

432	Bhabha Atom Res Ctr	43% of 432	Materials Science, Multidisciplinary [140]; Chemistry, Physical [123]; Physics, Condensed Matter [55]; Physics, Applied [52]; Physics, Atomic, Molecular & Chemical [47]	USA [19]; Germany [17]; Japan [16]; France [8]
249	Natl Phys Lab	43% of 249	Materials Science, Multidisciplinary [86]; Physics, Applied [75]; Physics, Condensed Matter [59]; Chemistry, Physical [27]; Electrochemistry [17]	Japan [13]; USA [11]; France [8]; England [4]; Germany [4]
241	Jawaharlal Nehru Ctr Adv Sci Res	31% of 241	Materials Science, Multidisciplinary [66]; Chemistry, Physical [57]; Chemistry, Multidisciplinary [46]; Physics, Condensed Matter [38]; Physics, Atomic, Molecular & Chemical [37]	USA [17]; Israel [4]; Italy [3]; Japan [3]
228	Indira Gandhi Ctr Atom Res	31% of 228	Materials Science, Multidisciplinary [76]; Physics, Condensed Matter [54]; Physics, Applied [35]; Metallurgy & Metallurgical Engineering [31]; Chemistry, Physical [28]	Germany [15]; Japan [14]; USA [10]; Taiwan [6]
224	Tata Inst Fundamental Res	34% of 224	Physics, Applied [73]; Physics, Condensed Matter [63]; Materials Science, Multidisciplinary [53]; Physics, Atomic, Molecular & Chemical [16]; Physics, Multidisciplinary [15]	USA [34]; France [10]; Japan [6]; Germany [6]
201	Univ Delhi	46% of 201	Materials Science, Multidisciplinary [42]; Physics, Condensed Matter [40]; Physics, Applied [32]; Chemistry, Physical [19]; Pharmacology & Pharmacy [15]	USA [18]; Japan [4]; Sweden [3]; Russia [2]; MA USA [2]; Australia [2]

Top Indian Nano Authors

The following table gives the top Indian authors by number of nano publications (1990-2006*), their affiliation, collaboration with other authors and countries and keywords specific to their research. We obtain these results by running the super profile macro on the authors field and further adding affiliation, authors, combined keywords and country fields to the profile.

Table 3. A Profile of the leading Indian Authors for Nanotechnology

#	Authors	Affiliation	Collaboration with Authors	Publication Year	Combined Keywords + Phrases (Cleaned)	Collaboration with Countries
			Top 5 Items	% since 2004	Top 5 Items	Top 5 Items
209	Sastry, M	Natl Chem Lab [207]	Pasricha, R [31]; Kumar, A [28]; Mandal, S [28]; Sainkar, S R [27]	35% of 209	format [84]; nanoparticle [82]; gold nanoparticle [75]; synthesis [59]; Langmuir Blodgett film [59]	India [209]; USA [3]; France [3]
188	Rao, C N R	Jawaharlal Nehru Ctr Adv Sci Res [129]	Govindaraj, A [84]; Kulkarni, G U [25]; Deepak, F L [22]; Satishkumar, B C [21]	26% of 188	nanotube [63]; carbon nanotube [42]; right reserved [41]; X-ray diffraction [32]; nanowire [32]	India [188]; USA [9]; Israel [3]; France [3]; Italy [2]; England [2]
93	Govindaraj, A	Jawaharlal Nehru Ctr Adv Sci Res [69]	Rao, C N R [84]; Deepak, F L [19]; Satishkumar, B C [19]; Sen, R [14]; Gundiah, G [14]	23% of 93	nanotube [45]; carbon nanotube [37]; right reserved [28]; nanowire [24]; pyrolysis [22]	India [93]; USA [4]; Japan [2]; France [2]
89	Kumar, A	Natl Chem Lab [30]	Sastry, M [28]; Malhotra, B D [10]; Mandale, A B [10]; Avasthi, D K [10]	47% of 89	right reserved [32]; film [28]; format [27]; nanoparticle [26]; particle [19]; FOURIER [19]	India [89]; France [6]; USA [4]; Poland [2]
85	Chakravorty, D	Indian Assoc Cultivat Sci [74]	Banerjee, S [20]; Das, D [16];	35% of 85	nanocomposite [37]; composite [32]; diameter [28];	India [85]; USA [5]; Taiwan [3];

			Kundu, T K [14]; Pal, M [14]		particle [27]; TEMPERATURE [26]	Italy [2]
84	Chaudhuri, S	Indian Assoc Cultivat Sci [81]	Kar, S [26]; Pal, A K [22]; Ganguli, D [21]; Chakrabarti, S [19]	60% of 84	film [37]; right reserved [35]; optical property [32]; growth [27]; nanoparticle [26]; PHOTOLUMINESCENT [26]	India [84]; South Korea [2]; France [2]
84	Pradeep, T	Indian Inst Technol [77]	Sandhyarani, N [17]; Nair, A S [10]; Tom, R T [9]; Venkataramanan, M [8]	27% of 84	monolayer self-assembled [31]; monolayer [29]; surface [23]; dynamic [21]; nanoparticle [20]	India [84]; USA [6]; Germany [3]; Japan [2]
83	Ghosh, S	Tata Inst Fundamental Res [12]	Avasthi, D K [10]; Sood, A K [9]; Arora, B M [8]; Ganesan, V [7]	49% of 83	right reserved [30]; study [17]; film [15]; effect [15]; result [15]	India [83]; Germany [14]; USA [6]; Japan [5]; South Korea [3]
76	Srivastava, O N	Banaras Hindu Univ [76]	Singh, A K [15]; Tiwari, R S [11]; Srivastava, A [9]; Yadav, T P [8]; Mukhopadhyay, N K [8]	29% of 76	synthesis [27]; format [25]; right reserved [25]; investigating [17]; CHARACTERIZE [16]	India [76]; DC USA [2]; France [2]
74	Sainkar, S R	Natl Chem Lab [74]	Sastry, M [27]; Patil, P P [10]; Vijayamohanan, K [9]; Mandale, A B [9]; Mulla, I S [9]; Rautaray, D [9]	20% of 74	right reserved [26]; Electron microscopy SEM [22]; format [22]; film [20]; surface [19]	India [74]; Germany [3]; USA [2]

Keywords (Indian Nano Publications)

The following is a list of most frequently used keywords for Indian publications. The different keywords and phrases fields are merged in Vantage Point. We then manually select relevant nano keywords and phrases from the merged field (excluding common modifiers).

Table 4. A list of most frequently used keywords for Indian publications.

Combined Keywords + Phrases	# Records
Film	1735
Nanoparticle	983
thin film	942
Composite	870
X-ray diffraction	815
electron microscopy	803
Morphology	681
OXIDE	674
SEM	667
XRD	642
Polym	602
Microstructure	532
Electron microscopy SEM	421
CLUSTER	415
Crystal	415
transmission electron microscopy	394
Nanocomposite	353
Nanocrystal	347
X-ray diffraction XRD	333
magnetic property	323
Alloy	318
Nanostructure	316
ELECTRIC PROPERTIES	311
FOURIER	303
SEMICONDUCTOR	300
TEM	284
surface morphology	281
Monolayer	279
SPECTROSCOPY	279
PHOTOLUMINESCENT	271
crystal structure	262
Lead	260
C-60	254
Langmuir Blodgett film	254
Absorption	252
pH	250
FULLERENE	249
thermal stability	247
ADSORPTION	240

Combined Keywords + Phrases	# Records
ELECTRODE	214
ACID	211
Gold	211
self assembly	211
Ceram	210
Nanotube	210
quantum dot	210
sol gel	210
MATRIX	208
CARBON	204
SI	204
carbon nanotube	203
Polymeric	196
Silver	196
infrared spectroscopy	195
DIFFUSION	194
Oxygen	194
X-ray photoelectron spectroscopy	194
SPECTRA	191
Membrane	190
Cd	189
Polyaniline	189
Ag	186
gold nanoparticle	184
Cu	179
HYDROGEN	179
Luminescent	179
Nanowire	179
XPS	176
monolayer self-assembled	175
Gel	174
IRRADIATION	174
optical absorption	173
Silica	171
X-ray photoelectron spectroscopy XPS	171
Sensor	169
band gap	163
activation energy	162
Raman spectroscopy	160

atomic force microscopy	239		COPPER	155
transmission electron microscopy				
TEM	227		Nanocrystalline	154
FTIR	216		phase transition	154
CRYSTALLIN	215		tiO2	153
CO	214		COPOLYMER	149

Source: Georgia Tech nano-publication database (WoS), 1990-2006*, using nano definition in Porter et al., 2007.

Conference Specific Keywords

We have tried to pick up some of the keywords specific to the lectures and topics in the conference.[4] A profile of these keywords for Indian publications has been made. To obtain these results, we created a data subset of the main keywords specific to the lectures and topics in the conference. The keywords are:

> Nanoscale, Nanomechanics, Nanostructures, Nanolayers, Bionanostructures And Biomimetics, Biomedicine/NEMS/Nanomanufacturing, Nanomagnetics, Nanoparticle, Nanophotoelectronics, and Nanoelectronics.

We then create a profile of the top keywords using the super profile macro.

Table 5. A Profile of some keywords specific to the conference (Indian authors)

	Combined Keywords + Phrases (Cleaned)	Affiliation (Name Only)	Authors (Cleaned)	Subject Category
	conference kw	Top 5 Items	Top 5 Items	Top 5 Items
24	nanoscale	Indian Inst Technol [6]; Indian Inst Sci [4]; Univ Castilla La Mancha [2]; Univ Allahabad [2]	Srinivas, V [2]; Bhowmick, A K [2]; Bandyopadhyay, A [2]; Vijayabaskar, V [2]; Yadav, R R [2]; Pandey, D K [2]; Patel, S [2]; Ram, S [2]; Roy, A [2]; De Toro, J A [2]	Materials Science, Multidisciplinary [8]; Physics, Condensed Matter [6]; Physics, Applied [5]; Physics, Multidisciplinary [3]; Chemistry, Physical [2]
8	silicon nanostructures	Indian Inst Technol [4]; Jawaharlal Nehru Univ [2]; Cent Elect Engn Res Inst [2]	Kumar, S [2]; Akhtar, J [2]; Pradhan, A [2]; Islam, M N [2]; Sen, P [2]	Physics, Applied [4]; Materials Science, Multidisciplinary [2]
6	nanoscale device	Dr Vijay Kumar Fdn [3]; Tohoku Univ [3]	Singh, A K [3]; Kumar, V [3]; Kawazoe, Y [3];	Materials Science, Multidisciplinary [3]; Chemistry, Multidisciplinary [2]; Physics, Condensed Matter [2]

[4] US-India Nanoscience and Engineering Institute (USINSEI), January 9-18, 2008, Chennai, India.

			Note, R [2]	
6	semiconductor nanostructures	Indian Inst Technol [2]	None	Physics, Applied [3]
6	ONE-DIMENSIONAL NANOSTRUCTURES	Indian Inst Sci [3]; Indian Assoc Cultivat Sci [2]	Chaudhuri, S [2]; Rao, C N R [2]	Materials Science, Multidisciplinary [3]; Chemistry, Physical [2]
5	NANOSCALE STRUCTURE	Indian Inst Technol [3]	None	Physics, Applied [3]; Engineering, Electrical & Electronic [2]; Materials Science, Multidisciplinary [2]
5	quantum confined nanostructures	Univ Allahabad [2]	Agrawal, B K [2]; Ghoshal, S K [2]; Gill, K S [2]; Agrawal, S [2]; Gupta, U [2]	Physics, Applied [2]

Source: Georgia Tech nano-publication database (WoS), 1990-2006*, see Porter et al., 2007.