Certification Course on Nano science & technology and Applications

By

Department of Humanities and Sciences

KSRM College of Engineering, Kadapa.

Date: 21st September 2021 to 3rd October 2021

Course Coordinator: Dr. R. Joyce Stella

Course Instructors:

1. Dr. R. Joyce Stella
   Dept of H&S, KSRMCE,
   Kadapa.

2. Dr. B. Ajitha
   School of Advanced Sciences,
   VIT, Chenni.

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)

Kadapa, Andhra Pradesh, India– 516 003

Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu.

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Lr./KSRMCE/ (Department of Humanities & Sciences)/2021-22

Date: **17.09.2021**

To

The Principal,
K.S.R.M. College of Engineering,
Kadapa.

From

Dr. R. Joyce Stella,
Assistant Professor,
Dept. of H&S,
K.S.R.M. College of Engineering
Kadapa.

Respected Sir,

Sub: KSRMCE - (Department of H&S) - Permission to conduct Certification Course on Nanotechnology & Industrial Applications - Requested - Reg.

I would like to bring to your kind notice that, the Department of H&S is planning to organise Certification Course on **"Nanoscience & Technology and Applications"** for B.Tech students from 21st September to 3rd October 2021 in online mode. In this regard I kindly request you to grant permission to conduct this course; I will be obliged for act of your kindness in this regard.

Thanking you sir,

Forwarded to
Dept of H&S

Yours Faithfully
R. Joyce stella.
Dr. Joyce Stella,
Coordinator,
Asst. professor,
Dept. of H&S,
K.S.R.M.C.E

Permitted
V. S. Murty

K.S.R.M. COLLEGE OF ENGINEERING

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Cr./KSRMCE/(Dept. of Humanities & Sciences)/2021-22 Date:17-9-2021

Circular

All B.Tech students are here by informed that Department of H&S is going to organize Certificate course on "Nanotechnology and Industrial Applications" from 21st September to 3rd October 2021. Interested candidates may register their names by using the following link. Last date 19-09-2021.

Registration Link: https://forms.gle/511EMeRrZmBXJtBR8

For any queries Contact,

Dr. R. Joyce Stella,
Coordinator,
Asst. Professor,
Dept. Of H&S,
K.S.R.M. College of Engineering.
Mobile No. 7997154714.
Mail Id: joycestella@ksrmce.ac.in

HOD H&S

Dr. I. SREEVANI M.Sc.,Ph.D.
Head of Humanities & Sciences
K.S.R.M College of Engineering
KADAPA - 516 005

Cc to:

The Management / Director /Deans/HoDs/IQAC for information

Registration Form for Certification Course on Nanotechnology & Industrial Application

Coordinator

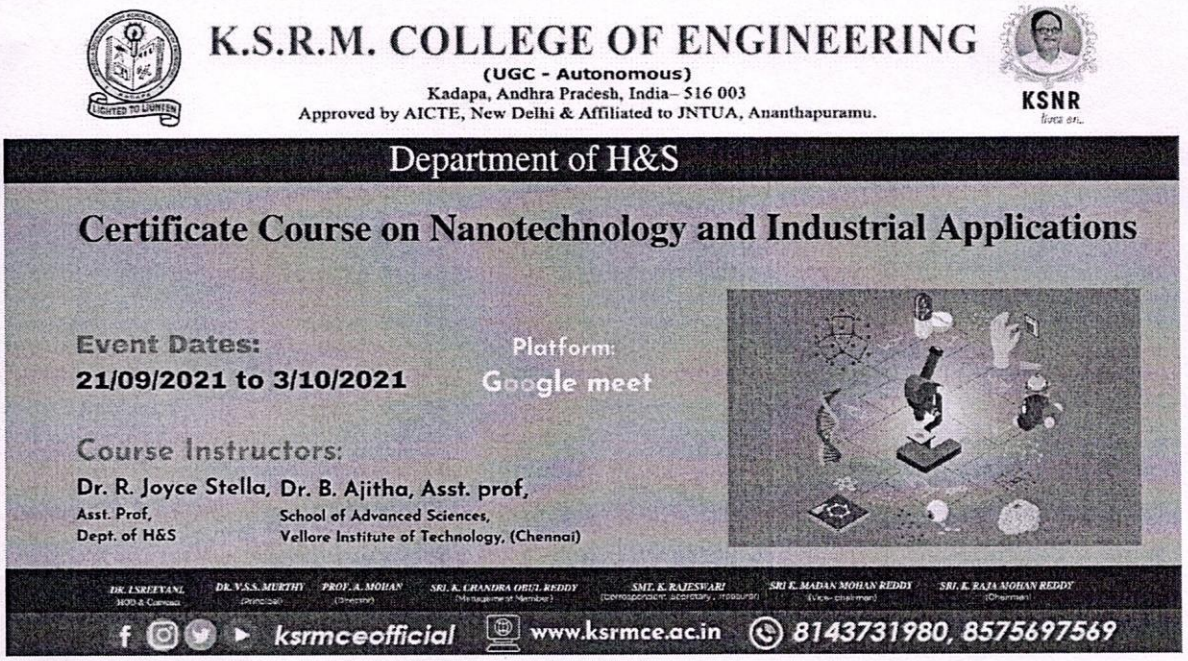
Dr. R. Joyce Stella, Department of H&S, K.S.R.M. College of Engineering, Kadapa.

Make sure to join the what's app group by using the Link which is provided after submission of your registration form.

* Required

1. Email *

Certification Course on Nanotechnology & Industrial Application



2. Enter your college mail id only *

3. Student Name *

4. Year and Semesters *

5. Branch

6. Permanent Roll Number (Ex. 209Y1A0130) *

Please Enter your correct register Number which is essential

7. Mobile Number (Preferably What's app Number) *

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)

Kadapa, Andhra Pradesh, India– 516 003

Certification Course on **"Nanotechnology & Industrial Applications"**

Registred Students List

Timestamp	Email Address	Student Name	Year and Semesters	Branch	Permanent Roll Number (Ex. 209Y1A0130)	Mobile Number (Preferably What's app Number)
9-19-2021 21:15:48	199y1a0133@ksrmce.ac.in	P.Venkata Siva	2021 & 5th Semester	Civil	199Y1A0133	6281744419
9-19-2021 21:24:45	199y1a0136@ksrmce.ac.in	Phatan Arfathulla Khan	3rd year and 1st sem	CE	199Y1A0136	9618566075
9-18-2021 15:25:45	209y1a0127@ksrmce.ac.in	KANDULA VIJAY KUMAR	1year 2 sem	Civil branch	209A1A0127	9398302073
9-19-2021 21:11:32	mahendrasai762@gmail.com	B.sai Mahendra reddy	1& 2	civil	209Y1A0110	7995921612
9-19-2021 20:20:54	209y1a0114@ksrmce.ac.in	Chavan sharaf Revanth sai	1&II	Civil	209y1a0114	9381822597
9-18-2021 16:33:19	cherasalaudaykiran@gmail.com	Cherasalaudaykiran	1year /2nd sem	Civil-A	209Y1A0116	8187067196
9-19-2021 13:37:46	209y1a0117@ksrmce.ac.in	Amarnath	2	Civil-A	209y1a0117	6303099189
9-19-2021 20:51:39	209Y1A0122@ksrmce.ac.in	J. Ganesh	2021 second sem	Civil-A	209Y1A0122	6302453127
9-18-2021 16:27:37	209y1a0131@ksrmce.ac.in	K. Praveenkumarreddy	1 Year 2 sem	Ce -a	209y1a0131	9642909043
9-18-2021 19:02:20	209y1a0132@ksrmce.ac.in	K.Rakesh Khanna	I year II sem	Civil A/S	209y1a0132	6304469710
9-18-2021 14:00:14	209y1a0133@ksrmce.ac.in	Koppala venkatasampath	1year 2sem	Civil A	209y1a0133	6305797210
9-20-2021 13:57:37	209y1a0140@ksrmce.ac.in	M.Vamsi Kumar	1st year 2nd sem	Civil engineering	209y1a0140	7780557613
9-18-2021 15:57:10	209y1a0149@ksrmce.ac.in	MUDE NARENDRA NAIK	1St year 2nd sem	CIVIL-A	209Y1A0149	9642926513
9-18-2021 14:06:57	nandyalasai75@gmail.com	NANDYALA NAGA SIVA SAI	2nd	Civil B	209Y1A0153	8688417093
9-18-2021 14:25:44	209y1a0171@ksrmce.ac.in	S.vamsi krishna	1 year / 2 sem	Civil	209y1a0171	8688581603
9-18-2021 13:39:00	syedmdzaheer.2002@gmail.com	Syed Mohammed Zaheer Ahamed	1st year 2nd sem	Civil	209Y1A0184	8106047725
9-21-2021 7:26:19	209y1a0227@ksrmce.ac.in	M. Mahalakshmi	1 and 2nd sem	EEE	209y1a0227	7659941608
9-19-2021 21:27:46	209y1a0238@ksrmce.ac.in	Saggam Sreekanth	1st year 2nd semester	EEE	209y1a0238	9390593534
9-19-2021 21:20:29	209y1a0246@ksrmce.ac.in	S. Sudharshan	1 st year, 2 nd semester	EEE	209y1a0246	7095914634
9-19-2021 20:28:07	deepaakula2003@gmail.com	A.Thulasi Deepa	1&2	Mechanical	209y1a0301	9100954809
9-21-2021 16:05:40	gladyjoy204@gmail.com	C.Vandana Evangeline	1&2	Mechanical	209y1a0310	8790490198
9-21-2021 15:04:34	209y1a0315@ksrmce.ac.in	ETUKURI GIRIDHAR KUMAR	1st year and 2nd semester	Mechanical engineering	209Y1A0315	8639086933
9-19-2021 21:08:01	209Y1A0322@KSRMCE.AC.IN	Jammalamadugu yuvaraju	1st year and 2nd semester	Mechanical	209Y1A0322	6301708531
9-21-2021 15:04:44	209y1a0361@ksrmce.ac.in	Syed waseem	1st year 2nd sem	Mechanical	209y1a0361	6303370297
9-19-2021 20:25:15	209y1a0364@ksrmce.ac.in	VELLATUR AKHIL KUMAR	1st year 2nd sem	MECHANICAL ENGINEEI	209y1a0364	9705638915
9-19-2021 21:08:46	209y1a0415@ksrmce.ac.in	B.Deepthi	1&2	Ece	209y1a0415	9014585886
9-20-2021 8:06:17	209y1a0448@ksrmce.ac.in	Galaganta Raghu	1st year 2nd semester	ECE	209Y1A0448	6309483767
9-20-2021 7:47:30	209y1a0450@ksrmce.ac.in	G Nithin kumar reddy	1&2	ECE	209Y1A0450	9346915203
9-19-2021 21:07:29	209y1a0455@ksrmce.ac.in	G.DADA VALI	2021&2nd	ECE	209Y1A0455	7993626020
9-19-2021 21:22:55	209Y1A0461@ksrmce.ac.in	g.harikrishna	1St year 2nd semester	ECE/B/S	209Y1A0461	8790196027
9-19-2021 21:24:19	209y1a0464@ksrmce.ac.in	Jalla Ganesh	IstYear & 2nd semester	ECE	209Y1A0464	8247040443
9-19-2021 21:41:57	209y1a04a0@ksrmce.ac	NANAYALA SUBBARAYUDU	1,2	ECE	209Y1A04A0	6281133787
9-20-2021 13:13:58	209Y1A04A4@ksrmce.ac.in	O. Praveen kumar	1-2	ECE-B	209Y1A04A4	9347088041
9-20-2021 15:49:41	209y1a04e2@ksrmce.ac.in	TATICHARLA VENKATA SAI	1st year and second sem	ECE	209Y1A04E2	7993862302
9-19-2021 23:13:41	209Y1A0542@KSRMCE.AC.IN	C.Jagadeeswar reddy	1 & II	CSE	209Y1A0542	9553584470
9-19-2021 21:33:07	singamsettyrishitha2912@gmail.com	S.Rishitha	1st,2nd	Cse	209Y1A05G2	7702017076
9-19-2021 22:16:36	209Y1A05I9@ksrmce.ac.in	Yelugoti Jeshnavi	1st year and 2nd sem	Cse-c	209Y1A05I9	6305872486

Dr. I. SREEVANI M.Sc.,Ph.D.
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K.S.R.M College of Engineering

Certification Course

Nanoscience & Technology and Applications

SYLLABUS

Course Objectives:

To enable the students to understand the concepts of the nanotechnology such as different parameters, properties and preparation techniques also improve their knowledge regarding this technology and make them familiarize the importance of this technology in various fields.

Unit I: Introduction to Nanoscale materials

Introduction – scientific revolutions – Nanoscale – Surface area to volume ratio and Size effect – *Special properties of Nanomaterials* – electrical, magnetic and mechanical properties.

Unit II: Nanostructured Materials

Definition of a nano system – classification based on nanomaterials- nanopowders, nanoporous materials, nanodust, nanowires and nanotube – Classification based on dimensions -0D, 1D, 2D and 3D.

Unit III: Fabrication Methods

Synthesis of nanomaterials *Top-down:* Ball Milling – principle – construction and working and applications – *Bottom-up:* Chemical Vapour Deposition – Sol-Gel method and Self Assembly – principle –construction and working.

Unit IV: Applications of Nanotechnology

Industrial Applications: Need of the nanotechnology in Industries – Energy – pollution control – data storage – Cosmetics and pigments – Sensors.

Biomedical Applications: Need of the nanotechnology in biomedical field – Nano cosmetics – Drug delivery and gene delivery by nanorobots – cell manipulation. Case studies: Nanorobots.

Unit V: Carbon Nano Tubes

Carbon nano tubes – properties – thermal, electrical and mechanical properties – preparation by Carbon Arc method – Electrical, molecular devices and biomedical applications of CNTs.

Course Outcomes: Students will be able to

- Illustrate the concepts of the nanotechnology and nano science and electrical, magnetic and mechanical properties of the nanomaterials.
- Classify the different types of the nanostructure materials also based on the dimensions.
- Demonstrate the different preparation techniques such as Top-down and Bottom-up approaches.
- Apply the ideas of this new and efficient technology in different fields like industrial and biomedical fields
- Explain the different concept of carbon nano tubes their peculiar properties, preparation and applications.

Text Books:

1. Text book of Nanoscience and Nanotechnology, B S Maruty, P. Shankar, Baldev Raj, B B Rath & James Murday by University Press (India) Private Limited (2012).
2. Nanoscience and Nanotechnology in Engineering, Vijay K Varadan by worlds Scientific publications (2010).

Reference Books:

1. Introduction to Nanoscience and Nanotechnology, K K Chattopadhyay and A N Benarjee by PHI Learning Prv. Ltd. (2014).
2. Nanotechnology, Gregory Timp by Springer (2005)
3. Introduction to Nanotechnology, Charles p Poole Jr, Frank J Owens by A Wiley Interscience Publications (2003).
4. "Nanotribiology" Critical Assessment and Research Needs, Stephen M. Hsu and Z. Charles Ying by Springer (2006)

Dr. I. SREEVANI M.Sc.,Ph.D
Head of Humanities & Sciences
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Department of Humanities and Sciences

Certification Course on Nanoscience & Technology and Sciences

Schedule

Date	Course Instructor	Topic to be covered	Timing
21-09-2021	Dr. R. Joyce Stella	Introduction to Nano Science and scientific revolutions	4.00 pm-6.00pm
22-09-2021	Dr. R. Joyce Stella	Nanoscale – Surface area to volume ratio and Size effect	4.00 pm-6.00pm
23-09-2021	Dr. R. Joyce Stella	*Special properties of Nanomaterials* – electrical, magnetic and mechanical properties.	4.00 pm-6.00pm
24-09-2021	Dr. R. Joyce Stella	Definition of a nano system, Classification based on nanomaterials- nanopowders, nanoporous materials,	4.00 pm-6.00pm
25-09-2021	Dr. R. Joyce Stella	Nanodust, nanowires and nanotube, Classification based on dimensions -0D, 1D, 2D and 3D.	4.00 pm-6.00pm
26-09-2021	Dr. R. Joyce Stella	Synthesis of nanomaterials *Top-down:* Ball Milling – principle – construction and working and applications	4.00 pm-6.00pm
27-09-2021	Dr. R. Joyce Stella	*Bottom-up:* Chemical Vapour Deposition principle – construction and working	4.00 pm-6.00pm
28-09-2021	Dr. R. Joyce Stella	Sol-Gel method principle – construction and working	4.00 pm-6.00pm
29-09-2021	Dr. R. Joyce Stella	Self Assembly principle – construction and working	4.00 pm-6.00pm

29-09-2021	Dr. B. Ajitha	*Industrial Applications:* Need of the nanotechnology in Industries – Energy	4.00 pm-6.00pm
30-09-2021	Dr. R. Joyce Stella	*Biomedical Applications:* Need of the nanotechnology in biomedical field – Nano cosmetics	4.00 pm-6.00pm
30-09-2021	Dr. B. Ajitha	Pollution control – data storage – Cosmetics and pigments – Sensors.	4.00 pm-6.00pm
01-10-2021	Dr. B. Ajitha	Carbon nano tubes – properties – thermal, electrical and mechanical properties	4.00 pm-6.00pm
02-10-2021	Dr. R. Joyce Stella	Drug delivery and gene delivery by nanorobots – cell manipulation. Case studies: Nanorobots.	4.00 pm-6.00pm
02-10-2021	Dr. B. Ajitha	Preparation by Carbon Arc method – Electrical, molecular devices and biomedical applications of CNTs	4.00 pm-6.00pm

R. Joycestella.
Coordinator

HOD H & S

Dr. I. SREEVANI M.Sc.,Ph.D.
Head of Humanities & Sciences
K S R M College of Engineering
KADAPA 516 005

Date: 11-10-2021

Name of the Event: Certification Course on Nanoscience & Technology and Applications

Venue : Google meet

List of Participants

S.No	Roll. Number	Name	Department	Contact No	Email Id
1.	199Y1A0133	P.Venkata Siva	CE	6281744419	199y1a0133@ksrmce.ac.in
2.	199Y1A0136	Phatan Arfathulla Khan	CE	9618566075	199y1a0136@ksrmce.ac.in
3.	209y1A0127	Kandula Vijay Kumar	CE	9398302073	209y1a0127@ksrmce.ac.in
4.	209Y1A0110	B.Sai Mahendra Reddy	CE	7995921612	mahendrasai762@gmail.com
5.	209y1a0114	Ch. Sharaf Revanth Sai	CE	9381822597	209y1a0114@ksrmce.ac.in
6.	209Y1A0116	Cherasalaudaykiran	CE	8187067196	cherasalaudaykiran@gmail.com
7.	209Y1A0122	J. Ganesh	CE	6302453127	209Y1A0122@ksrmce.ac.in
8.	209y1a0131	K. Praveenkumarreddy	CE	9642909043	209y1a0131@ksrmce.ac.in
9.	209y1a0132	K.Rakesh Khanna	CE	6304469710	209y1a0132@ksrmce.ac.in
10.	209y1a0140	M.Vamsi Kumar	CE	7780557613	209y1a0140@ksrmce.ac.in
11.	209Y1A0149	Mude Narendra Naik	CE	9642926513	209y1a0149@ksrmce.ac.in
12.	209y1a0171	S.Vamsi Krishna	CE	8688581603	209y1a0171@ksrmce.ac.in
13.	209y1a0238	Saggam Sreekanth	EEE	9390593534	209y1a0238@ksrmce.ac.in
14.	209y1a0301	A.Thulasi Deepa	ME	9100954809	deepaakula2003@gmail.com

15.	209Y1A0315	Etukuri Giridhar Kumar	ME	8639086933	209y1a0315@ksrmce.ac.in
16.	209Y1A0322	J. Yuvaraju	ME	6301708531	209Y1A0322@ ksrmce.ac.in
17.	209y1a0364	Vellatur Akhil Kumar	ME	9705638915	209y1a0364@ksrmce.ac.in
18.	209Y1A0450	G Nithin Kumar Reddy	ECE	9346915203	209y1a0450@ksrmce.ac.in
19.	209Y1A04A0	Nanayala Subbarayudu	ECE	6281133787	209y1a04a0@ksrmce.ac
20.	209Y1A04E2	Taticharla Venkata Sai	ECE	7993862302	209y1a04e2@ksrmce.ac.in
21.	209Y1A0542	C.Jagadeeswar Reddy	CSE	9553584470	209Y1A0542@ ksrmce.ac.in
22.	209Y1A05I9	Yelugoti Jeshnavi	CSE	6305872486	209Y1A05I9@ksrmce.ac.in

R. Joycestella.
Co-ordinator

HOD

Dr. I. SREEVANI M.Sc.,Ph.D.
Head of Humanities & Sciences
K S R M College of Engineering
K A D A P A - 516 005

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)

Kadapa, Andhra Pradesh, India– 516 003

Certification Course on "Nanotechnology & Industrial Applications"

Attendance Sheet

Roll Number	Student Name	Branch	21-09-2021	22-09-2021	23-09-2021	24-09-2021	25-09-2021	26-09-2021	27-09-2021	28-09-2021	29-09-2021	29-09-2021	30-09-2021	30-09-2021	01-10-2021	02-10-2021	02-10-2021
199Y1A0133	P.Venkata Siva	CE	P	P	A	P	P	A	P	A	A	P	P	A	A	A	A
199Y1A0136	Phatan Arfathulla Khan	CE	A	A	A	A	A	P	A	A	A	A	A	P	P	P	P
209y1A0127	KANDULA VIJAY KUMAR	CE	P	P	P	P	P	P	A	A	P	P	A	A	A	P	P
209Y1A0110	B.sai Mahendra reddy	civil	P	P	A	A	A	A	A	A	A	P	A	P	P	P	P
209y1a0114	Chavan sharaf Revanth sai	Civil	P	P	P	P	P	A	A	P	A	P	A	P	P	A	A
209Y1A0116	Cherasalaudaykiran	Civil-A	P	P	P	P	P	P	A	A	A	P	A	A	A	P	P
209Y1A0122	J. Ganesh	Civil-A	A	P	P	A	P	A	P	P	P	P	A	A	A	P	P
209y1a0131	K. Praveenkumarreddy	Ce -a	A	P	P	A	A	P	A	P	P	P	A	A	A	A	A
209y1a0132	K.Rakesh Khanna	Civil A/S	P	P	A	P	P	P	A	A	A	P	A	P	P	P	P
209y1a0140	M.Vamsi Kumar	CE	P	A	A	A	A	A	A	A	A	A	P	P		P	P
209Y1A0149	MUDE NARENDRA NAIK	CIVIL-A	A	A	P	P	P	P	A	P	P	A	A	P	P	A	A
209y1a0171	S.vamsi krishna	Civil	P	P	P	P	P	P	P	P	A	P	P	A	A	P	P
209y1a0238	Saggam Sreekanth	EEE	A	A	A	A	A	A	P	A	A	A	A	P	P	P	P
209y1a0301	A.Thulasi Deepa	ME	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
209Y1A0315	ETUKURI GIRIDHAR KUMA	ME	A	A	P	A	A	A	A	A	A	A	A	P	P	P	P
209Y1A0322	Jammalamadugu yuvaraju	ME	A	A	A	P	A	P	P	P	P	A	P	P	P	A	A
209y1a0364	VELLATUR AKHIL KUMAR	ME	A	P	P	P	A	P	P	A	A	P	A	A	P	A	A
209Y1A0450	G Nithin kumar reddy	ECE	A	A	A	A	A	P	A	A	A	A	A	A	P	A	A
209Y1A04A0	NANAYALA SUBBARAYUD	ECE	A	A	A	A	A	P	A	A	P	A	P	P	P	P	P
209Y1A04E2	TATICHARLA VENKATA S	ECE	P	A	A	A	A	A	A	A	A	A	A	A	A	P	P
209Y1A0542	C.Jagadeeswar reddy	CSE	P	P	P	P	P	P	P	P	P	P	P	A	A	P	P
209Y1A0519	Yelugoti Jeshnavi	Cse-c	P	P	A	P	A	P	P	P	A	P	A	P	P	P	P

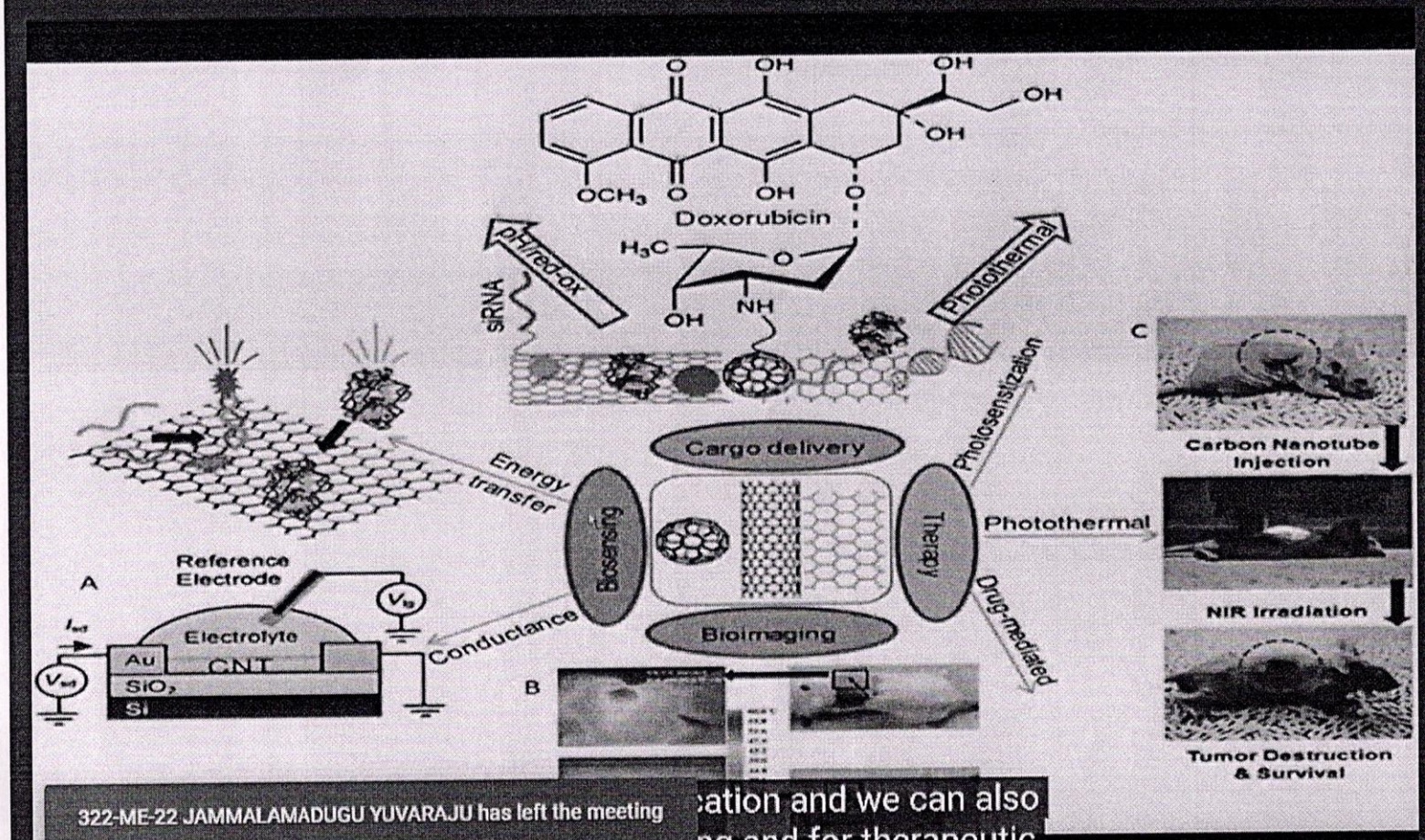
R Joyce Stella
Coordinator

HOD 5/11/2021

Dr. I. SREEVANI M.Sc.,Ph.D
Head of Humanities & Sciences
K.S.R.M College of Engineering
KADAPA - 516 005

REC

Ajitha అజిత is presenting



322-ME-22 JAMMALAMADUGU YUVARAJU has left the meeting

...cation and we can also use it for bio sensing and for therapeutic

Ajitha అజిత

122-JANAGANA GA...

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J

You

Activate Windows
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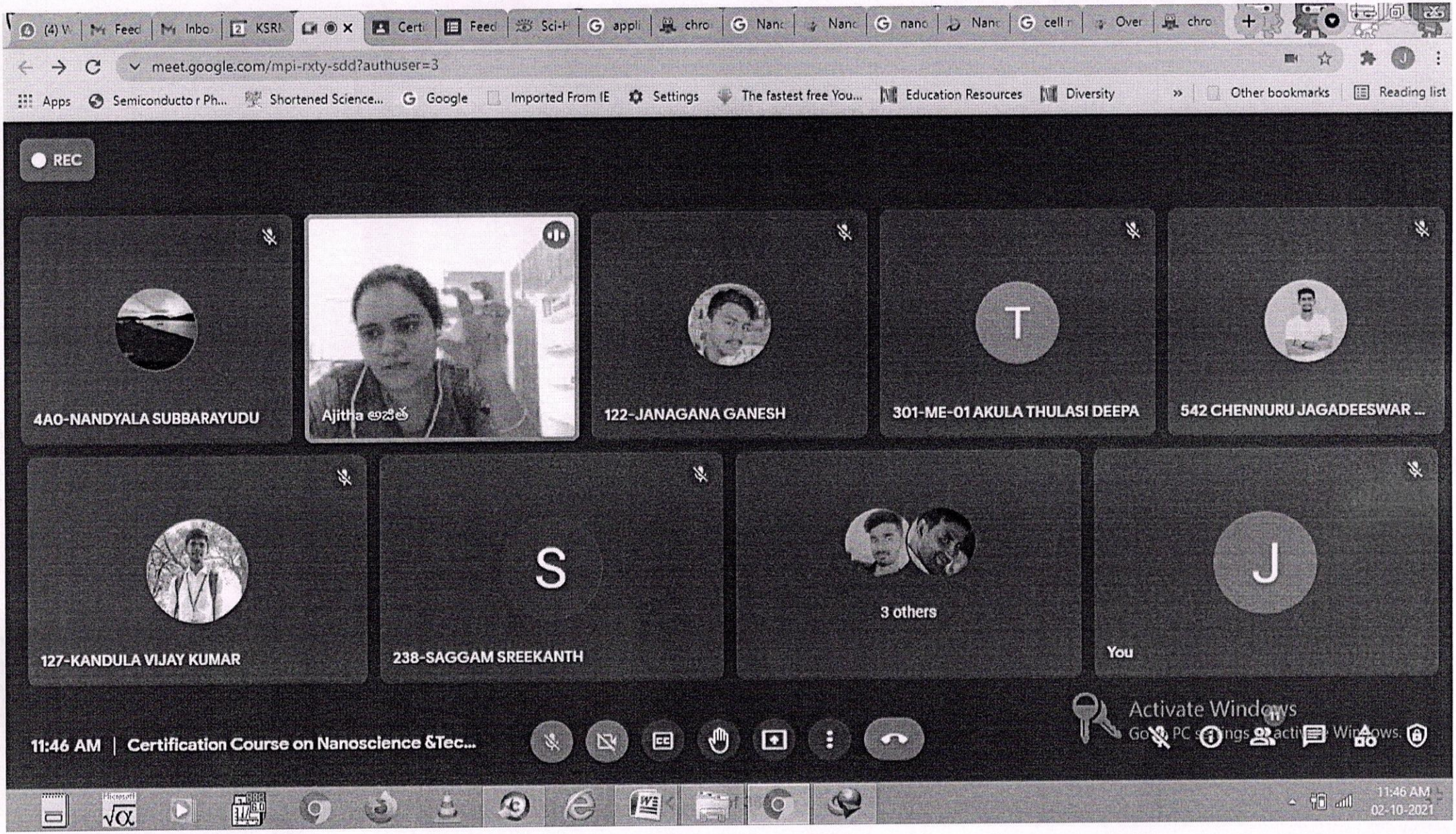
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REC
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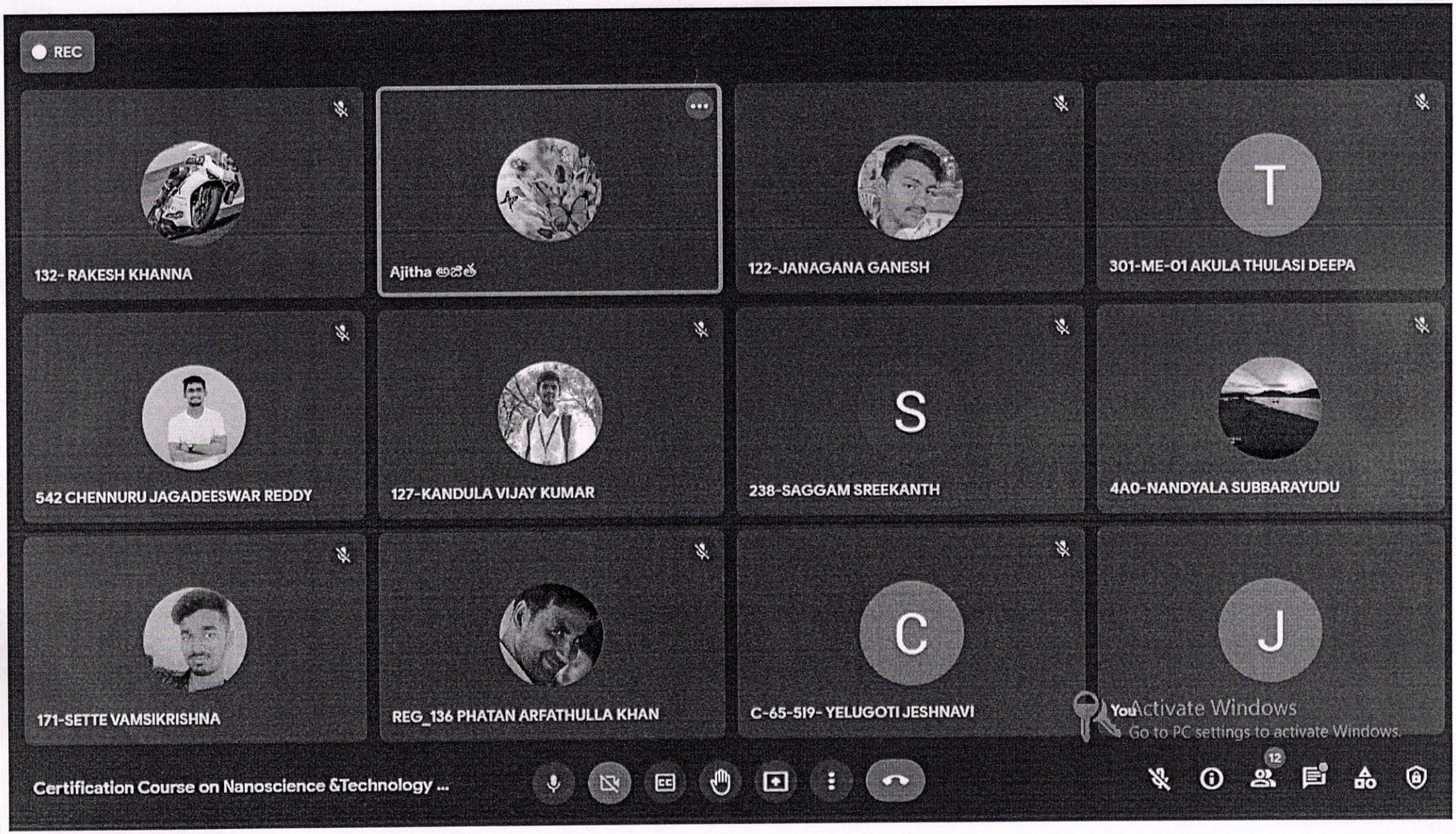
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122-JANAGANA GANESH
301-ME-01 AKULA THULASI DEEPA
542 CHENNURU JAGADEESWAR REDDY
127-KANDULA VIJAY KUMAR
238-SAGGAM SREEKANTH
4A0-NANDYALA SUBBARAYUDU
171-SETTE VAMSIKRISHNA
REG_136 PHATAN ARFATHULLA KHAN
C-65-519- YELUGOTI JESHNAVI
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Activate Windows
Go to PC settings to activate Windows.
Certification Course on Nanoscience &Technology ...
12

K.S.R.M. COLLEGE OF ENGINEERING

(UGC - Autonomous)

Kadapa, Andhra Pradesh, India– 516 003

Approved by AICTE, New Delhi & Affiliated to JNTUA, Ananthapuramu.

KSNR
lives on..

Department of H&S

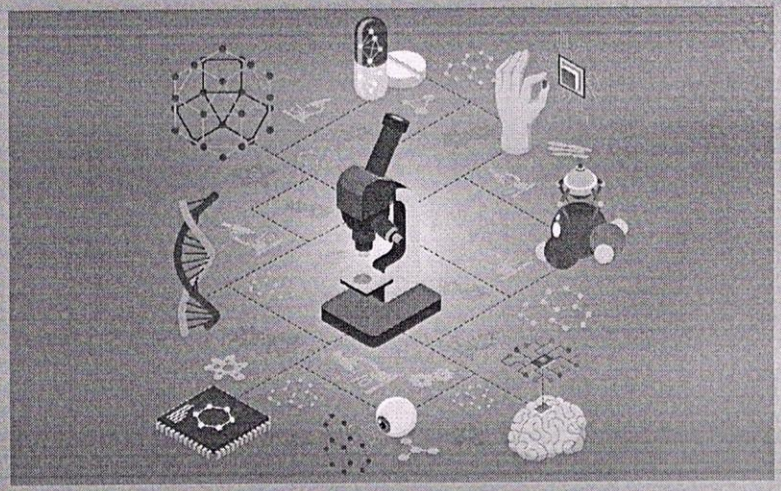
Certification Course on Nanoscience & Technology and Applications.

Event Dates:

21/09/2021 to 3/10/2021

Platform:

Google meet



Course Instructors:

Dr. R. Joyce Stella,
Asst. Prof,
Dept. of H&S

Dr. B. Ajitha, Asst. prof,
School of Advanced Sciences,
Vellore Institute of Technology, (Chennai)

ACTIVITY REPORT

Certification Course

On

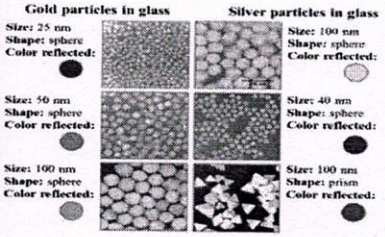
"Nanoscience & Technology and Applications"

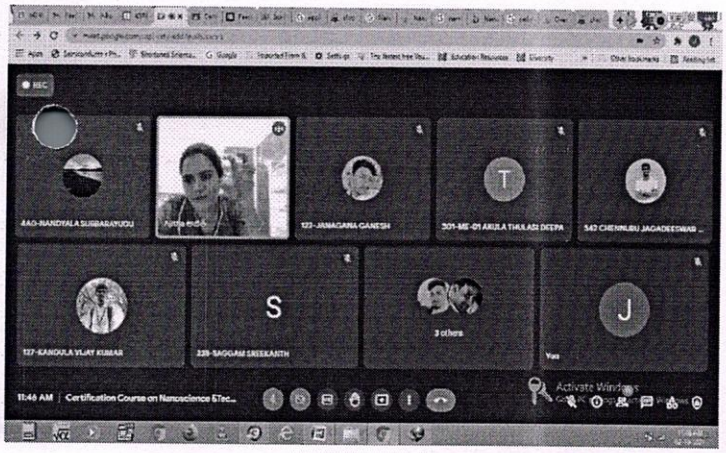
21st September, 2021 to 2nd October, 2021

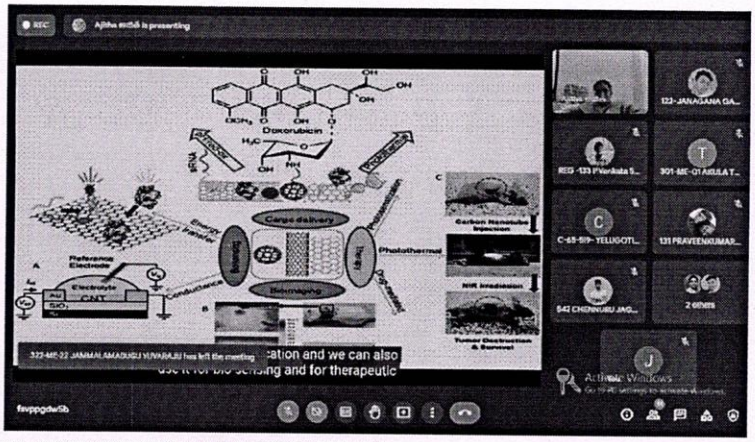
Target Group	**:**	**Students**
Details of Participants	**:**	**22 Students**
Co-ordinator	**:**	**Dr. R. Joyce Stella** **Asst. Prof, Dept. of H&S**
Organizing Department	**:**	**Department of Humanities & Sciences**
Venue	**:**	**Online mode (Google meet)**

Description : Certification course on Nanoscience & Technology and Applications was organized by Dept. of H&S from 21st September 2021 to 2nd October 2021 in online mode. The Course instructors are Dr. R. Joyce Stella & Dr. B. Ajitha. The main aim of the course is to create awareness among students about the new and awesome technology that is the science of Nano. By using this technology one can prepare the very advanced materials with tremendous applications. This course covered preparation techniques of the advanced materials and how corresponding course is applied in various fields like medical and industrial. Course is completed and certificates are provided for the participants.

Photo :







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KSNR

Course Completion Certificate

This is to certify that **Mr. C. Jagadeeswar reddy** bearing Roll number 209Y1A0542 has successfully completed his **certification course on Nanoscience & technology and Applications** organized by **Department of H&S, K.S.R.M.C.E.**, Kadapa, A.P from 21/09/2021 to 2/10/2021.

Dr. I. Sreevani	Dr. V.S.S. Murthy	Prof. A. Mohan
HOD, H&S	Principal	Director

R. Joyce Stella.

Dr. R. Joyce Stella
Coordinator

Dr.I.Sreevani
HOD H&S

Dr. I. SREEVANI M.Sc.,Ph.D.
Head of Humanities & Sciences
K.S.R.M. College of Engineering
KADAPA-516 005

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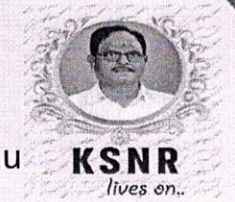

Course Completion Certificate

This is to certify that **Mr. P. Venkata Siva** bearing Roll number 199Y1A0133 has successfully completed his **certification course on Nanoscience & technology and Applications** organized by **Department of H&S, K.S.R.M.C.E.**, Kadapa, A.P from 21/09/2021 to 2/10/2021.

Dr. I. Sreevani	**Dr. V.S.S. Murthy**	**Prof. A. Mohan**
HOD, H&S	**Principal**	**Director**

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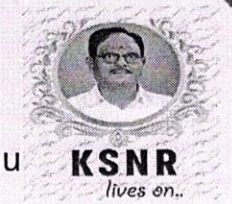

Course Completion Certificate

This is to certify that **Mr. J. Ganesh** bearing Roll number 209Y1A0122 has successfully completed his **certification course on Nanoscience & technology and Applications** organized by **Department of H&S, K.S.R.M.C.E.**, Kadapa, A.P from 21/09/2021 to 2/10/2021.

Dr. I. Sreevani	**Dr. V.S.S. Murthy**	**Prof. A. Mohan**
HOD, H&S	**Principal**	**Director**

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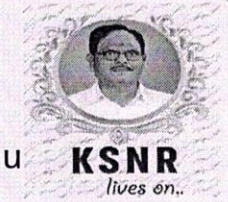

Course Completion Certificate

This is to certify that **Mr. C. Jagadeeswar Reddy** bearing Roll number 209Y1A0542 has successfully completed his **certification course on Nanoscience & technology and Applications** organized by **Department of H&S, K.S.R.M.C.E.**, Kadapa, A.P from 21/09/2021 to 2/10/2021.

Dr. I. Sreevani	**Dr. V.S.S. Murthy**	**Prof. A. Mohan**
HOD, H&S	**Principal**	**Director**

Certification Course on Nanoscience &Technology and A...
B. Tech

Stream Classwork People Grades

Customize

Certification Course on Nanoscience &Tech...

B. Tech

Class code 47fiu4v
Subject Nanoscience &Technology and Applications
Certification Course on Nanoscience &Technology and Applications

Announce something to your class

Dr. R. Joyce Stella
Oct 2

The feedback link of the course is:https://forms.gle/WcqLhRVySyNK8EMQ8

Add class comment...

Dr. R. Joyce Stella
Oct 2

Certification Course on Nanoscience &Technology and Applications
Saturday, 2 October · 10:30 am
Google Meet joining info
Video call link: https://meet.google.com/mpi-rxty-sdd

Dear students this is today's class link. join to the class by 10:30 am.

1 class comment

Feedback form of Certification course on Nanoscience & Technology and Applications

By
Dr. R. Joyce Stella
Assistant Professor
H & S Department
KSRMCE, Kadapa

The respondent's email (**null**) was recorded on submission of this form.
* Required

1. Email *

2. Email ID *

3. Name *

4. Roll Number *

5. Branch & Section *

6. Phone Number *

7. Address *

8. How well the Course met your expectation *

Mark only one oval.

	1	2	3	4	
poor	◯	◯	◯	◯	excellent

9. How well the concepts are presented *

Mark only one oval.

	1	2	3	4	
Poor	◯	◯	◯	◯	Excelent

10. How well the all the sessions helped us to increasing your knowledge *

Mark only one oval.

- ◯ excellent
- ◯ good
- ◯ average
- ◯ poor

11. How well the sessions is for interaction *

Mark only one oval.

	1	2	3	4	
poor	◯	◯	◯	◯	excellent

12. How well Guest Presented the concepts *

Mark only one oval.

- ◯ Excellent
- ◯ Good
- ◯ Average
- ◯ poor

13. Do you want to participate like this courses in future *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

14. Any suggestions *

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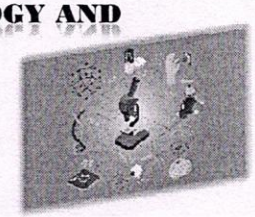
Feedback Form Responses Sheet for certification course on Nanoscience & technology and Applications

Email Address	Timestamp	Name	Roll Number	Branch & Section	Phone Number	Address	ourse met y	concepts a	How well the all	sessions is	How well Guest	Do you want	Any suggestions
199y1a0133@ksrmce.ac.in	10-21-2021 11:06:58	PAGIDI VENKATA SIVA	199Y1A00133	Civil & A/S	6281744419	36/800-1-1 , Chinna Ch	4	4	excellent	4	Excellent	Yes	To know Many Things in this course...
199y1a0136@ksrmce.ac.in	10-2-2021 12:20:23	Phatan Arfathulla Khan	199Y1A0136	CE and A/s	9618566075	9/185-22-4-1	4	4	excellent	4	Excellent	Yes	No suggestion to this coarse because it reached my expectations
209y1a0110@ksrmce.ac.in	10-21-2021 11:14:25	B.SAI MAHENDRA REDDY	209Y1A0110	Civil-A	7995921612	Kadapa (D) chapadu (n	4	4	excellent	4	Excellent	Yes	Good
209y1a0114@ksrmce.ac.in	10-21-2021 10:51:00	Chavan sharaf Revanth sai	209y1a0114	Civil A	9381822597	Habibullha street	4	4	excellent	4	Excellent	Yes	No
209y1a0116@ksrmce.ac.in	10-21-2021 10:23:50	Cherasalaudaykiran	209Y1A0116	CIVIL-A	8187067196	Kadapa	4	4	excellent	4	Excellent	Maybe	No suggestions
209y1a0122@ksrmce.ac.in	10-2-2021 11:58:36	J Ganesh	209y1a0122	Civil A	6302453127	7-62 .Edulapalli .Mudigu	4	4	excellent	4	Excellent	Yes	Very well teaching mam
209y1a0127@ksrmce.ac.in	10-2-2021 11:50:49	KANDULA VIJAY KUMAR	209Y1A0127	Civil-A sec	9398302073	3/160,shivalayam Stree	4	4	excellent	4	Excellent	Yes	No suggestions mam
209y1a0131@ksrmce.ac.in	10-21-2021 10:48:12	K.praveenkumarreddy	209y1a0131	Ce_a	9642909043	Iti circle,kadapa	4	4	excellent	3	Good	Yes	No
209y1a0132@ksrmce.ac.in	10-2-2021 12:09:29	K.Rakesh Khanna	209y1a0132	Civil A/S	6304479710	D.no :1/1886 sree ram r	3	4	excellent	4	Excellent	Yes	No suggestions
209y1a0140@ksrmce.ac.in	10-2-2021 13:01:02	M.Vamsi Kumar	209y1a0140	Civil a s	7780557613	Kadapa	3	3	good	3	Good	Yes	No suggestions
209y1a0149@ksrmce.ac.in	10-21-2021 12:05:13	MUDE NARENDRA NAIK	209y1a0149	CIVIL-A	9642926513	Kadapa	4	4	excellent	4	Excellent	Yes	This course is very usefull to all peoples
209y1a0171@ksrmce.ac.in	10-2-2021 11:52:16	S.vamsi krishna	209y1a0171	Civil /B sec	8688581603	Kurnool (d) pattikonda	3	4	excellent	4	Excellent	Yes	It is very use full to all of them
209y1a0238@ksrmce.ac.in	10-2-2021 12:08:14	Saggam Sreekanth	209y1a0238	EEE	9390593534	Pulivendula	4	4	excellent	4	Excellent	Yes	Nice course
209y1a0301@ksrmce.ac.in	10-2-2021 12:07:19	A Thulasi Deepa	01	Mechanical	9100954809	Vijaya Nagar colony nea	4	4	excellent	4	Excellent	Yes	Nothing
209y1a0315@ksrmce.ac.in	10-22-2021 17:33:32	Etukuri Giridhar kumar	209y1a0315	ME	8639086933	Kovvurivandlapalli (villa	4	3	excellent	4	Excellent	Maybe	Great explanation about nano technology
209y1a0322@ksrmce.ac.in	10-2-2021 12:52:01	Jammalamadugu Yuvaraju	209Y1A0322	Mechanical	6301708531	3/2-765,(Ammavarishal	4	4	good	3	Excellent	Yes	This course is very useful of my future ,thanks Madam
209y1a0364@ksrmce.ac.in	10-21-2021 14:11:20	Vellatur Akhil Kumar	209y1a0364	Mechanical	9705638915	Vellatur 3-46b pendlima	4	4	good	4	Good	Yes	Nothing to say
209y1a0450@ksrmce.ac.in	10-4-2021 17:17:06	G Nithin Kumar Reddy	209y1a0450	ECE\A	9346915203	Alavalapadu (village)V	4	4	excellent	4	Excellent	Yes	It's good
209y1a04a0@ksrmce.ac.in	10-2-2021 12:18:31	NANDYALA SUBBARAYUDU	209Y1A04A0	ECE-B	6281133787	Ksrm college of enginee	4	4	excellent	3	Excellent	Yes	No
209y1a04e2@ksrmce.ac.in	10-2-2021 12:07:24	TATICHARLA VENKATA SAI	209Y1A04E2	ECE C SECTION	7993862302	42/589-3 NGO COLON	3	3	good	3	Good	Maybe	No suggestions needed
209y1a0542@ksrmce.ac.in	10-2-2021 11:54:50	C.JAGADEESWAR REDDY	209Y1A0542	CAE A	9553584470	KADAPA,AP	4	4	excellent	4	Excellent	Yes	Thank you so much mam
209y1a05i9@ksrmce.ac.in	10-2-2021 11:51:21	Yelugoti Jeshnavi	209Y1A05I9	CSE -C	6305872486	Karm college of enginee	4	4	excellent	4	Excellent	Yes	Understand

R Joyastella.

Dr. I. SREEVANI M.Sc.,Ph.D
Head of Humanities & Sciences
K.S.R.M. College of Engineering
KADAPA - 516 005

NANOTECHNOLOGY AND INDUSTRIAL APPLICATIONS



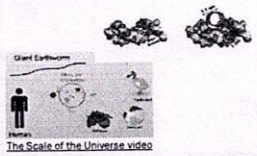
BY
Dr. R. Joyce Stella
Assistant Professor
Department of H & S
KSRM College of Engineering
Kadapa.

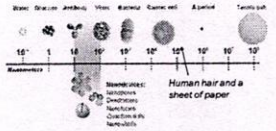
INTRODUCTION

- **Nanoscience**
  - Nanoscience is an emerging area of science which involves the study of materials on an ultra-small scale and the novel properties that these materials demonstrate.
- **Nanotechnology**
  - Nanotechnology is the understanding and control of matter at the nanoscale, at dimensions between approximately 1 and 100 nanometres, where unique phenomena enable novel applications.

WHAT IS NANO?

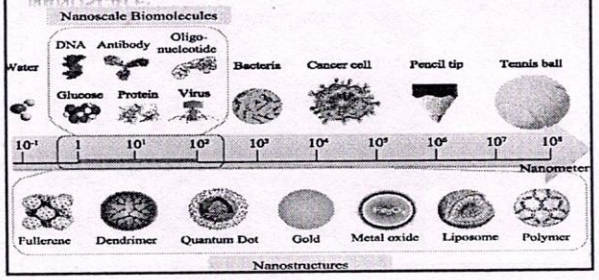
- **Nanotechnology** is science, engineering, and technology conducted at the nanoscale (about 1 to 100 nanometers)
- **Nano** can refer to technologies, materials, particles, objects – we are focusing on ***nanomaterials*** as these are already being used in workplaces more widely
- A sheet of paper is about 100,000 nanometers thick, a human hair is around 80,000- 100,000 nanometers wide.





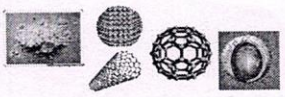
The Scale of the Universe video

NANOSCALE:



TYPES OF NANOMATERIALS

- Nanomaterials can...
  - occur naturally
  - be produced by human activity either as a product of another activity
  - on purpose (engineered)
- Our focus: *engineered* nanomaterials as these are designed and integrated into products because of the specific characteristics of the nanomaterial

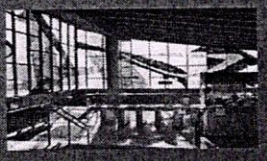


Naturally Occurring	Human Origin (Incidental)	Human Origin (Engineered)
Forest fires	Cooking smoke	Metals
Sea spray	Diesel exhaust	Quantum dots
Mineral composites	Welding fumes	Buckyballs/Nanotubes
Volcanic ash	Industrial effluents	Sunscreen pigments
Viruses	Sandblasting	Nanoparticles

Nanotechnology

Brief History

An early example of a manmade nanoprocess is stained glass



History, Continued

Dr. Richard P. Feynman
1959
One of America's most notable physicists, 1965.

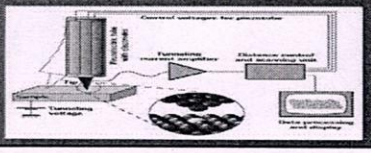
- Why can't we manipulate materials atom by atom?
- Why can't we control the synthesis of individual molecules?
- Why can't we write all of human knowledge on the head of a pin?
- Why can't we build machines to accomplish these things?

History, Continued

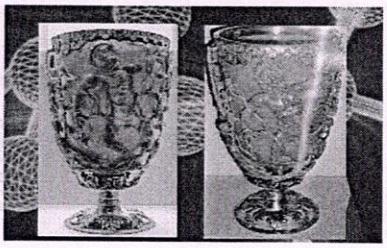
Nobel Prize 1986

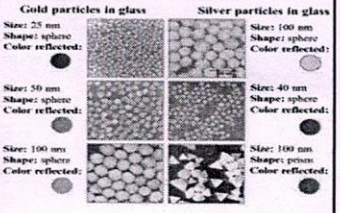
Gerd Binnig

Heinrich Rohrer



1,600-YEAR-OLD GOBLET SHOWS ROMANS USED NANOTECHNOLOGY

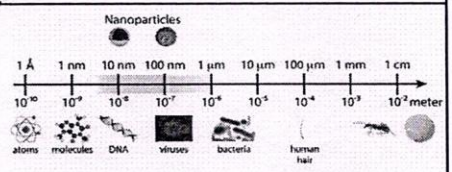




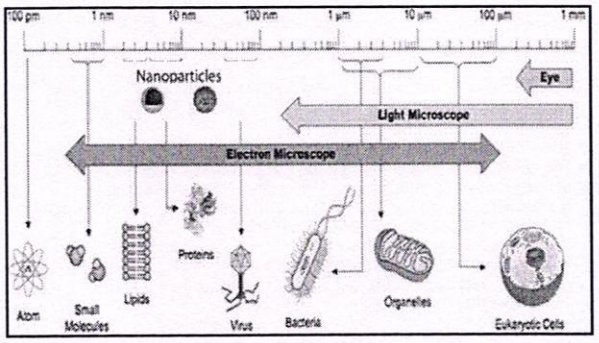
WHY IS NANO

- The Greek word "nano" is derived from the word "dwarf" meaning reduction in size or small
- usually any material whose size is in the range of 1-100 nm at least in one of its dimensions is normally considered as a nanomaterials
- The nanometre (nm) scale is typically defined as one billionth of a meter (10^{-9} m) which usually consists of 10 to 10^5 atoms.

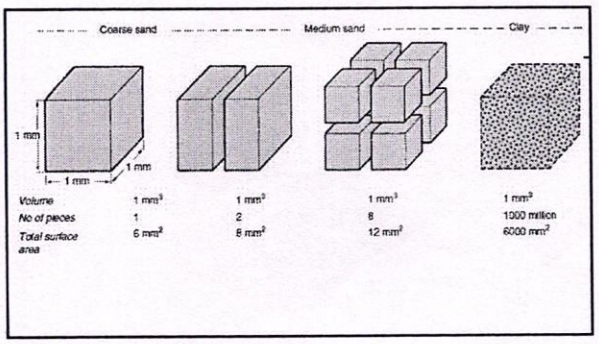
NANOSCALE

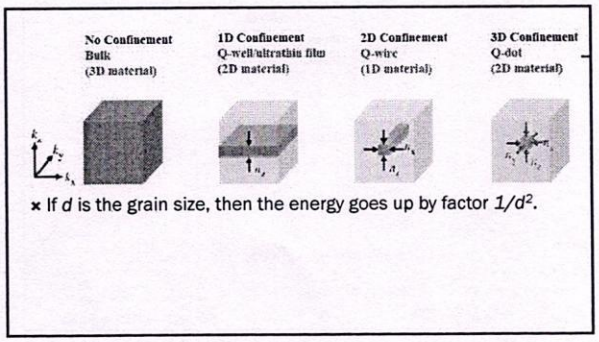


- Nanomaterials act as the bridging materials between microparticles and atoms.
- Nanomaterials exhibit unique properties compared with bulk materials owing to quantum effects.

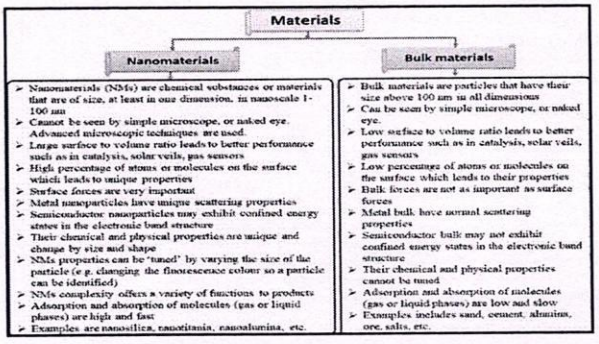


- The size of nanomaterials is in the order of nanometre dimensions which limit its visibility with human eye.
- Different types of electronic microscopes are normally employed to see different types of nanomaterials.
- The visibility range of different materials using electron and optical microscopes, and human eye





- If d is the grain size, then the energy goes up by factor $1/d^2$.



PROPERTIES OF THE NANOMATERIALS

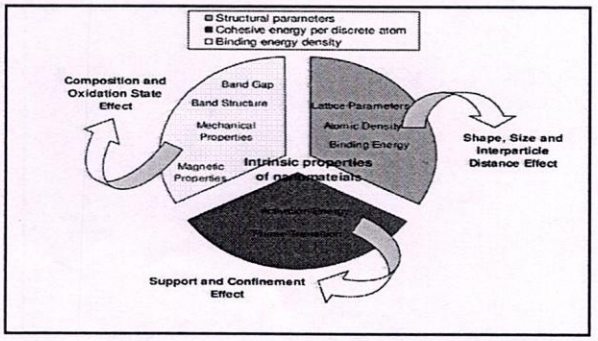
- Since the size of the particle is very less the particles are very close to each other and hence the inter particle spacing is very less in nano materials.
- The energy bands in these materials will be very narrow.
- The ionization potential is found to be higher for nano materials.
- In nano materials a large number of atoms will be present at the surface. These atoms will have less coordination number and hence posses local magnetic moment with-in themselves.
- Due to large magnetic moment these nano materials exhibits spontaneous magnetization at smaller sizes.
- Nanomaterials exhibit different unique properties owing to the existence of quantum effects.

ELECTRICAL PROPERTIES

- The properties conductivity or resistivity are come under category like of electrical properties.

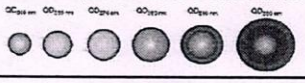
The change in electrical properties in nanomaterials are:

- Conductivity of a bulk or large material does not depend upon dimensions like diameter or area of cross section and twist in the conducting wire etc.
- It is also observed that conductivity also changes when some shear force (in simple terms twist) is given to nanotube.
- The electrical properties of the nanomaterial triggered a response in the mesenchymal (adult) stem cells, which we sourced from human bone marrow.
- In effect, they became electrified, which made them alter into more cardiac-like cells



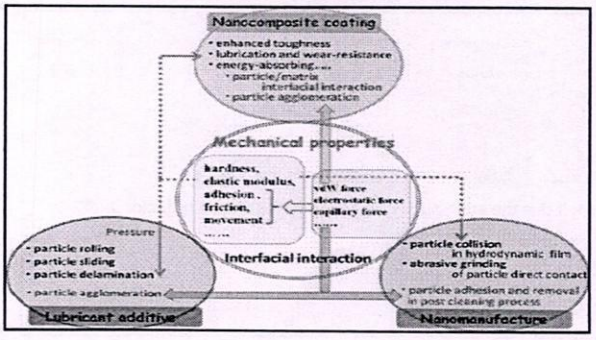
OPTICAL PROPERTIES

- The size dependence the optical properties of nanoparticles is the result of two distinct on phenomena:
- Surface Plasmon resonance for metals
- Increased energy level spacing due to the confinement of delocalized energy states. Most prominent in semiconductors.
- Energy level spacing and quantum confinement:
- As semiconductor particle size is reduced the band gap is increased.
- Absorbance and luminescence spectra are blue shifted with decreasing particle size



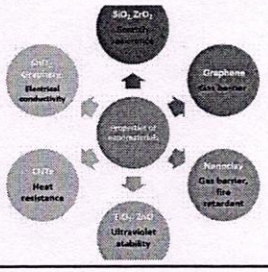
MAGNETIC PROPERTIES

- Nano scale has a big impact on the magnetic properties!
- In a normally ferromagnetic material, nano scale reduces the moment, but it can be restored by applying a magnetic field.
- As the coordination number decreases, the moment increases towards the atomic value. i.e., small particles are more magnetic than bulk material.
- The magnetic moment of Co_n particles of 2 nm exhibited
- 20% higher value than that of the bulk.
- Fe, Co and Ni ferromagnetic particles in bulk , exhibit superparamagnetic behaviour at nanophase.
- Paramagnets like Na, K at bulk exhibit ferromagnetic property at nanoscale.
- Nanoparticles of even non magnetic solids are found to be magnetic.
- It has been found theoretically as well as experimentally that the magnetism is special to small sizes and disappears in clusters containing more than 80 atoms.
- Ferromagnetic and antiferromagnetic multilayers have been found to exhibit *giant magneto-resistance* (GMR).

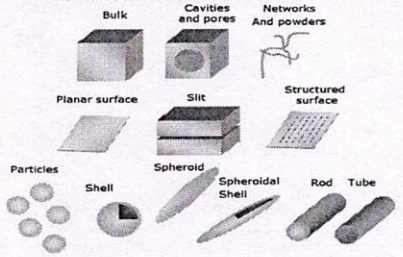


EXAMPLES

- Examples of some materials with different properties



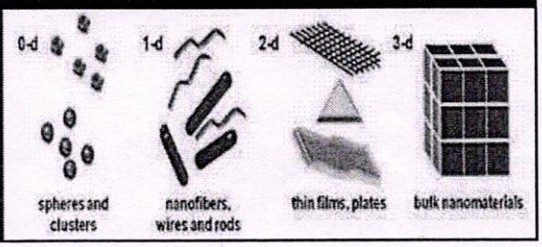
NANOSTRUCTURED MATERIALS



TYPES OF NANOMATERIALS-

- Nanomaterials can be nanoscale in one dimension(eg surface films), two dimensions (eg strands of fibres), or three dimensions (eg. Particles).
- They can exist in single, fused, aggregated or agglomerated forms with spherical, tubular and irregular shapes.common types of nanomaterial includes-
- Nanotubes
- Dendrimers
- Quantum dots
- Fullerenes
- composites

- According to SIEGEL, nanostructured materials are classified as zero dimensional, one dimensional , two dimensional, three dimensional nanostructures



Nanomaterials can be classified primarily into two types:

Natural and artificially fabricated

- Natural nanomaterials: These include nanomaterials that exist in biological systems

e.g. viruses(capsid), substances in our bone matrix, ribosome machinery, ATPase etc

- Artificial nanomaterials: These are the ones that are fabricated by different experiments. They can further sub-divided into 4 classes:

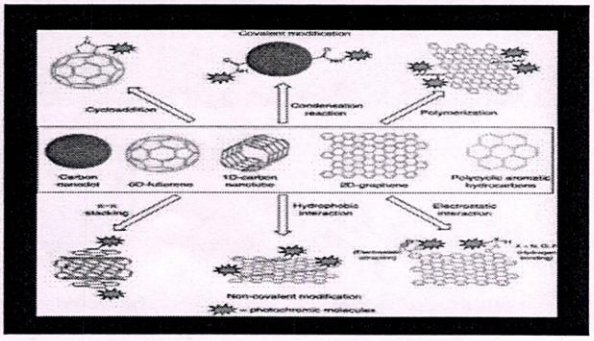
Carbon Based: These nanomaterials are composed mostly of carbon, most commonly taking the form of a hollow spheres, ellipsoids, or tubes. Spherical and ellipsoidal carbon nanomaterials are referred to as fullerenes, while cylindrical ones are called carbon nanotubes(CNTs).

- In 1985 ; Smalley , Curl and Kroto invented a new form of carbon made of 60 carbon atoms known as Bucky balls.
- Graphite can be rolled into cylinder with a diameter of about 1 nm. These strong but light carbon nanotubes are used in sensors, computers and televisions.

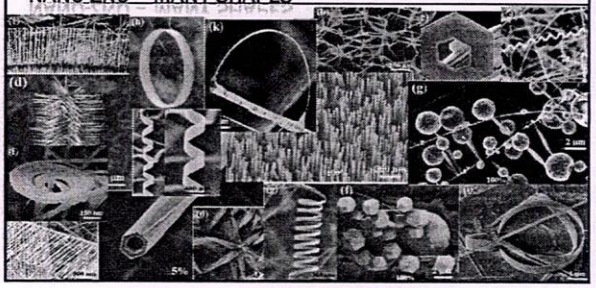
- Metal Based: These nanomaterials include quantum dots, nanogold, nanosilver and metal oxides, such as titanium dioxide. Metal particle size can be controlled by changing temperature, pressure, concentration, pH, ultrasound application. With increase in temperature there will be decrease in particle size.
- Nucleation is required for growth of nanoparticles
- Homogenous nucleation-
- Form simultaneously and uniformly throughout the solution
- Heterogenous nucleation-
- $Ag^{+} + e^{-} \longrightarrow Ag^{0}$(seed)

  $Ag^{0} + Ni^{2+} + 2e^{-} \longrightarrow Ni^{0}$ (nano scale particle)
- Dendrimers: These nanomaterials are nanosized polymers built from branched units. The surface of a dendrimer has numerous chain ends, which can be tailored to perform specific chemical functions.

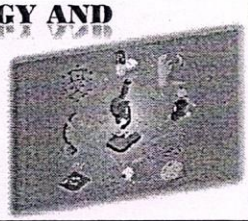
- The three-dimensional dendrimers contain interior cavities into which other molecules could be placed, they may be useful for drug delivery.
- Composites: Composites combine nanoparticles with other nanoparticles or with larger, bulk-type materials. The composites may be any combination of metal based, carbon based or polymer based nanomaterials with any form of metal, ceramic, or polymer bulk materials



NANO-ZNO – MANY SHAPES

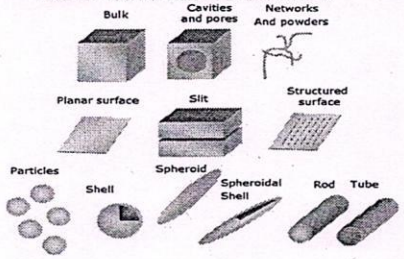


NANOTECHNOLOGY AND INDUSTRIAL APPLICATIONS



BY
Dr. R. Joyce Stella
Assistant Professor
Department of H & S
KSRM College of Engineering
Kadapa.

NANOSTRUCTURED MATERIALS



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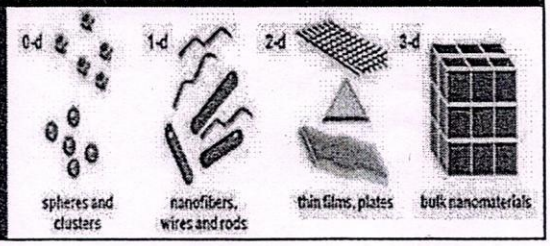

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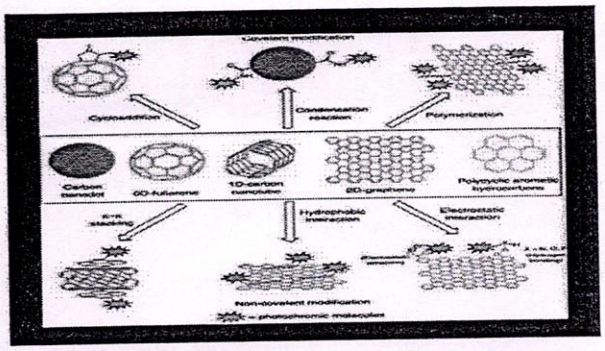
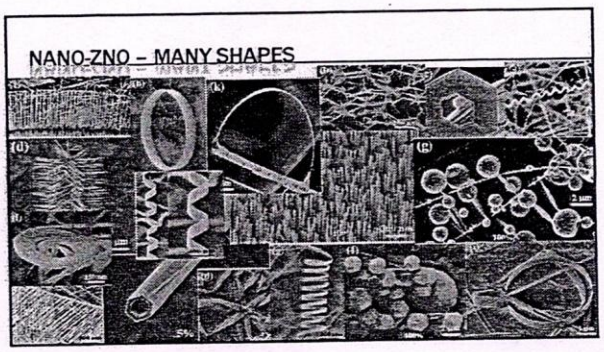
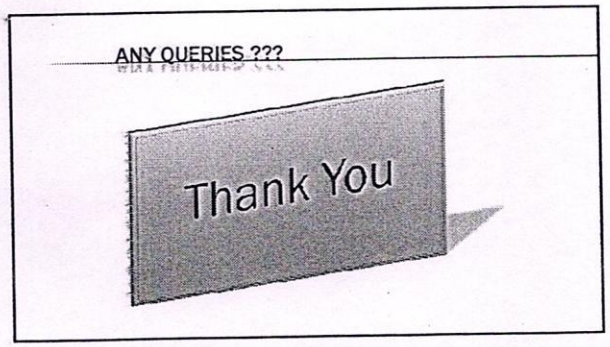


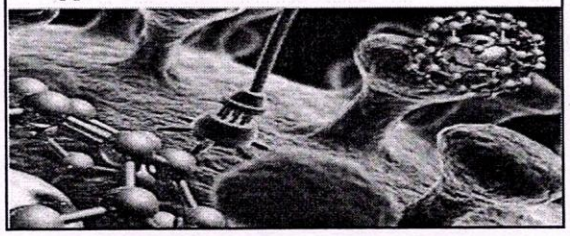




NANOTECHNOLOGY
Class- 1
Unit-III, Chapter-I

Topics cover through Nanotechnologg are…

- Basics of Nano materials
- Preparation and characterization – CNTs
- Applications of Nano materials.



Introduction to Nano Materials

Materials form an integral part of our life. Advancement in our day today life leads to the discovery of many new engineering materials.

We know all materials are composed of atoms with different sizes which have movement with one another. There exist special clause of materials in which the atoms do not move away from each other and its size will be in the order of 1to 100 nano meters. These new materials are called ***nano-materials*** and the developed technology is called ***nano-technology***. Using the highly sophisticated latest technology the nano-materials can also be formed from metals, ceramics, and polymers and even from liquids.

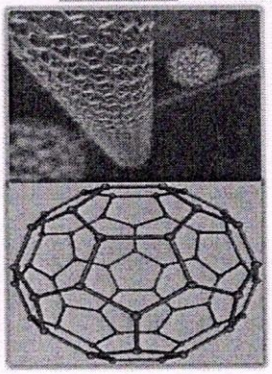
Nano particles are the particles with in size ranging from 1 – 50nm.

Nano materials are the materials having components with in size 1nm to 100nm in one dimension.

Nano technology is the manipulation of mater on molecular scale and study the use of structures between 1nm to 100nm

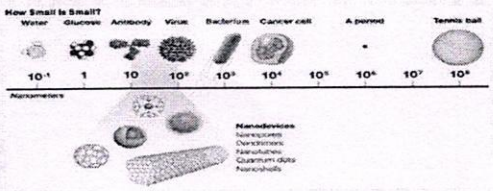
Defination

- **Nanotechnology** is the study of manipulating matter on an atomic scale.
- **Nanotechnology** refers to the constructing and engineering of the functional systems at very micro level or we can say at atomic level.
- A **Nanometer** is one billionth of a meter, roughly the width of three or four atoms. The average human hair is about 25,000 nanometers wide.



SO WHAT IS NANO?

- NANO is a *GREEK* word meaning *EXTREMELY SMALL.*
- Nanotechnology deals with sizes from 1-100nm range
- A nanometer is very very small its 10^{-9} m.



NANO & TECHNOLOGY

- A **Nano**metre is a unit of length in the metric system, equal to one billionth of a metre(10^{-9}).
- **Technology** is the making, usage, and knowledge of tools, machines and techniques, in order to solve a problem or perform a specific function.

Properties of Nano Particle

i. Since the size of the particle is very less the particles are very close to each other and hence the inter particle spacing is very less in nano materials.
ii. The energy bands in these materials will be very narrow.
iii. The ionization potential is found to be higher for nano materials.
iv. In nano materials a large number of atoms will be present at the surface. These atoms will have less coordination number and hence posses local magnetic moment with in themselves.
v. Due to large magnetic moment these nano materials exhibits spontaneous magnetization at smaller sizes.

Nano Scale

Nano stands for 10^{-9}. A nano meter (nm) is one billionth or one thousand millionth of a meter or 10^{-9} of a meter. For comparison the carbon- carbon bond length is the order of 0.12 – 15 nm. A human hair is 80000 nm wide.

Fabrication of Nano Materials

Nano phase materials can be generally fabricated in any of the two ways.

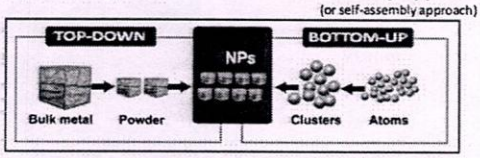
Top down approach: - In which bulk materials are broken into nano sizes as shown.

Bottom up approach: - In which nano materials are made by building atom by atom.

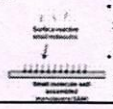
Nanoparticle Synthesis

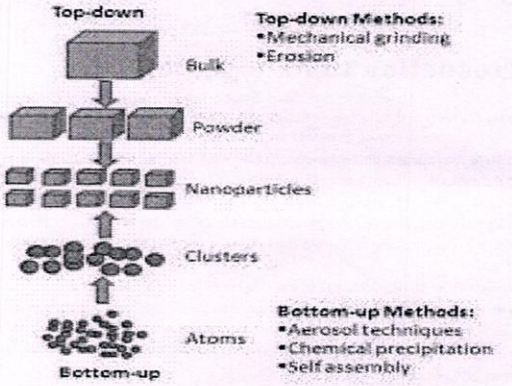
There are two approaches for synthesis of nanomaterials and the fabrication of nano structures.

Top-Down approach | **Bottom-Up approach** (or self-assembly approach)



- Top down approach refers to slicing or successive cutting of a bulk material to get nano sized particle.
- Bottom up approach refers to the build up of a material from the bottom: atom by atom, molecule by molecule
- Atom by atom deposition leads to formation of Self- assembly of atoms/molecules and clusters
- These clusters come together to form self-assembled monolayers on the surface of substrate





TOP-DOWN APPROACH

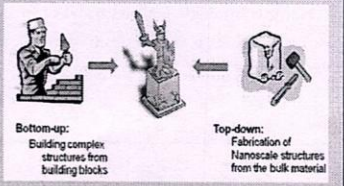
- These seek to create smaller devices by using larger ones to direct their assembly.
- Usually top-down approach is used less then bottom-up approach
- Solid-state silicon methods.
- They can create features smaller than 100 nm.

This device transfers energy from nano-thin layers of quantum wells to nanocrystals above them, causing the nanocrystals to emit visible light.

Top down Approach

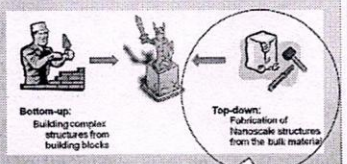
Approaches[1]

- Bottom-up
- Top-down



Approaches[1]

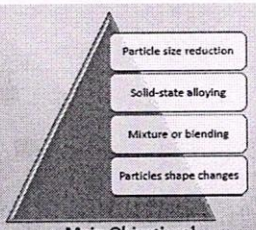
- Bottom-up
- Top-down



Mechanical Milling

Milling Applications

- Minerals Processing
- Ceramics Processing
- Powders Metallurgy



Main Objectives[1]

Type of Mill devices[1]

- Tumblers mills
- Attrition mills
- Shaker mills
- Vibratory mills
- Planetary mils

Choice of milling equipment

Type of Mill devices[1]

- Tumblers mills
- Attrition mills
- Shaker mills
- Vibratory mills
- Planetary mils


Wind mill


Flour Mill


4 kW coffee Mill

Industry

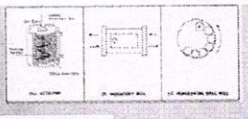

Horizontal mills

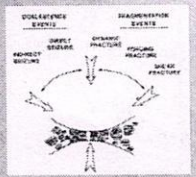
Laboratory


Planetary


Shaker

- Milling Parameters and Basic Process





D. R. MAURICE and T.H. COURTNEY, The Physics of Mechanical Alloying: A First Report, METALLURGICAL TRANSACTIONS A, VOLUME 21A, FEBRUARY 1990—289

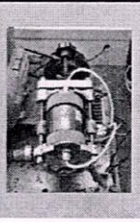
- Friedrich Wilhelm Ostwald (2 September 1853 – 4 April 1932)
- Nobel Laureate in Chemistry - 1909
- In 1887, he coined the term "mechanochemistry", as a part of physical chemistry as thermochemistry, electrochemistry, or photochemistry

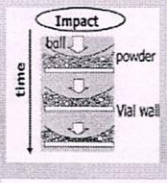
***Mechanochemistry** is the chemistry in which the thermodynamic state variables and functions of a given chemical system, including at least one solid phase, change in response to the effects of non-hydrostatic mechanical stresses, and of the resulting plastic strain.*

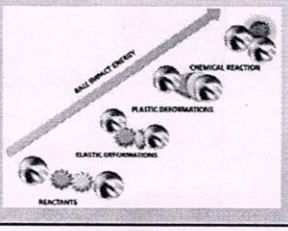
- 3rd century BC - Theophrastus of Eresus – De Lapidibus (On Stones)

Reduction of Cinnabar

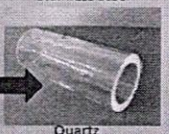
$HgS + Cu \longrightarrow Hg + CuS$





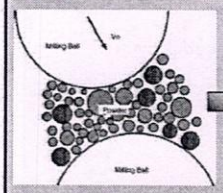


Stainless steel



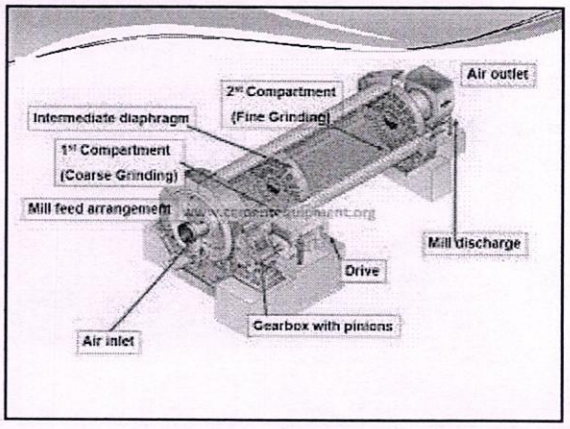
Quartz

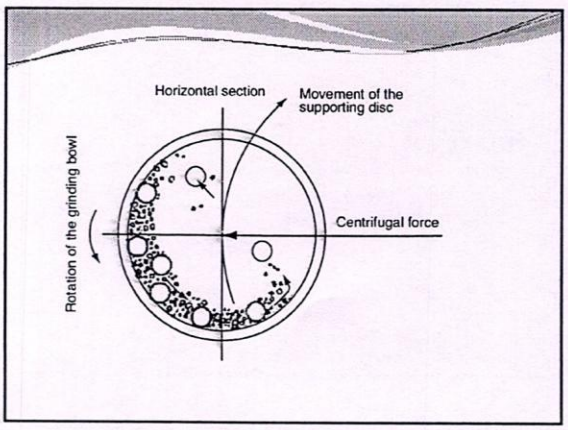
Since these species are quite lightweight, we have to push our experiments to the femtosecond time scale. Furthermore.....



- Powder trapped at each collision: 0.1 mg
- Powder involved in trasformation: 0.34%

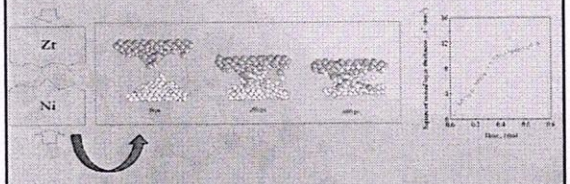
Also for the most expert scientist in TEM characterization could be impossible to find 0.00034 mg in 8 g of powders. Be patient!





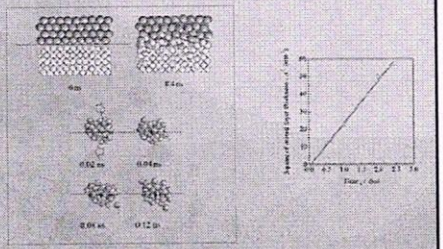
- Collisions are randomly distributed over the whole powder charge
- A small fraction of the powder charge is involved in each collision
- Powders are perfectly homogenized after each collision.
- Phase transformations occur on a fraction of the trapped powders as a result of th mechanical deformation processes associated to the collisions
- Times of the order of the collision duration are required for the phas transformations to occur

Collision



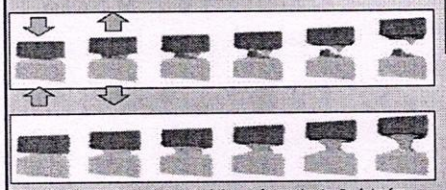
In the case of collision events, the mixing of atomic species displays two different regimes characterized by different apparent diffusion rates

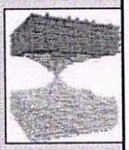
Shearing



The thickness of such layer increases with time according to a power law similar to the one characteristic of thermal diffusion, although on a different time scale

A look to the atomistic processes in metals...



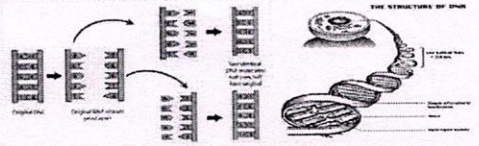


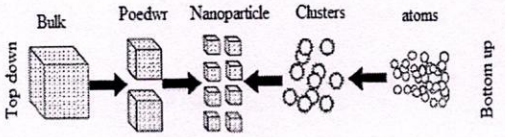
Role of surface asperities

Stress-induced mixing and material transfer at the Au-Ru interfoce

BOTTOM-UP APPROACH

- Assembling nano materials atom – by – atom or molecule – by – molecule (self assembling).
- This approach is much cheaper.
- Things become much larger.
- Examples of molecule self assembly are Watson–Crick basepairing and nano-lithoghraphy.





Various techniques are adopted for the fabrication of nano phase materials; Using all techniques it is possible to produce nano phase materials in the form of nano -particles, nano- powders, nano -crystals nano -films, nano- wires, nano -tubes and nano -dots etc.,

Bottom-Up Approach

By
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Assistance Professor
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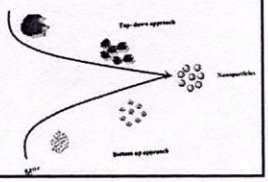


Background

CVD involves the dissociation and/or chemical reactions of gaseous reactants in an activated (heat, light, plasma) environment, followed by the formation of a stable solid product.

The formation of soot due to incomplete oxidation of firewood since prehistoric times is probably the oldest example of deposition using CVD.

- Patent literature by de Lodyguine in 1893 on the deposition of W onto carbon lamp filaments through the reduction of WCl_6 by H_2 lead to the industrial exploitation of CVD.

What is CVD?

- Chemical vapor deposition (CVD) is a process whereby a solid material is deposited from a vapor by a chemical reaction occurring on or in the vicinity of a normally heated substrate surface.
- The solid material is obtained as a coating, a powder, or as single crystals.
- By varying the experimental conditions—substrate material, substrate temperature, composition of the reaction gas mixture, total pressure gas flows, etc.—materials with different properties can be grown.
- CVD is an example for Solid-Vapor Reaction.

Main Components of CVD Equipment

1. Chemical vapour precursor supply system

- The role of this component is to generate vapour precursors and then deliver to the reactor.
- The design of the CVD reactor depends on whether the starting material is solid, liquid or gas.
- The sublimation of a solid precursor depends on surface area of the solid and contact time.
- Liquid sources often use a bubbler to vaporise the reactants, and a carrier gas (reactive gases such as H_2 or inert gases such as Ar) to transport the vaporised reactants into the reactor.

2. CVD reactors

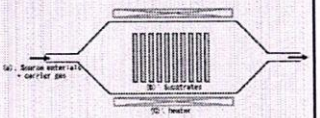
Hot-wall reactor:

- ✓ In this the substrate (wafer) and the walls of the reactor are heated, i.e. a homogeneous temperature is maintained inside the reaction chamber.

Disadvantage of hot-wall reactor

- ✗ Contamination

Cold-wall reactor:



- ✓ This reactors uses heating systems that minimize the heating up of the reactor walls while the wafer is being heated up. The temperature is not homogeneous inside the reaction chamber.

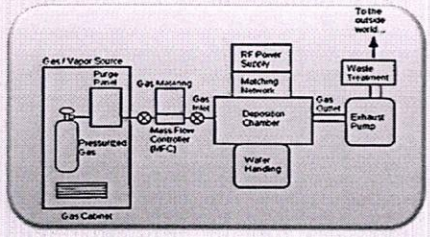
Disadvantage of cold-wall reactor

- ✗ It is difficult to get a uniform layer of the film.

3. The effluent gas handling system

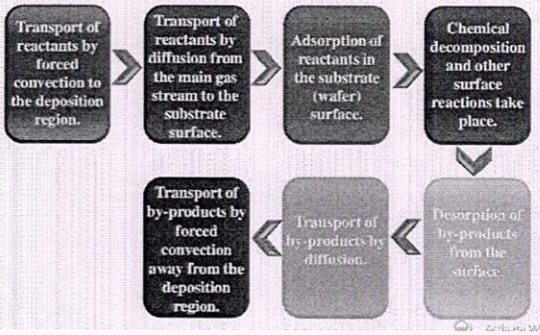
- This component consists of a neutralizing part for the exhaust gases, and/or a vacuum system to provide the required reduced pressure for the CVD process that performs at low pressure or high vacuum during deposition.
- The unreacted precursors and corrosive by-products such as HCl are neutralised or trapped using a liquid nitrogen trap.
- Inflammable gases such as hydrogen are burned off.
- Unreacted expensive precursors may be collected at the outlet and recycled.

CVD Equipment

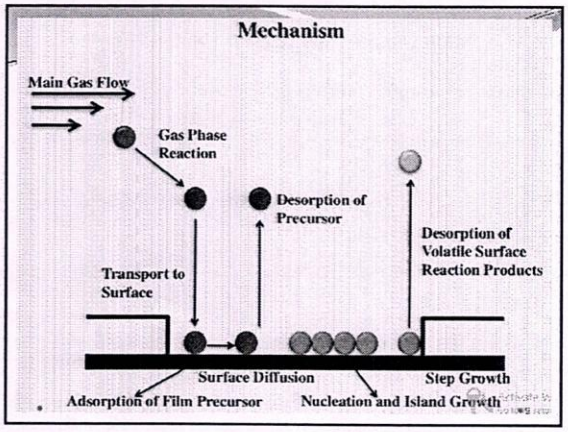


- In a typical CVD process, the substrate is exposed to one or more volatile precursors which react and decompose on the substrate surface to produce the desired deposit.
- During this process, volatile by-products are also produced, which are removed by gas flow through the reaction chamber.

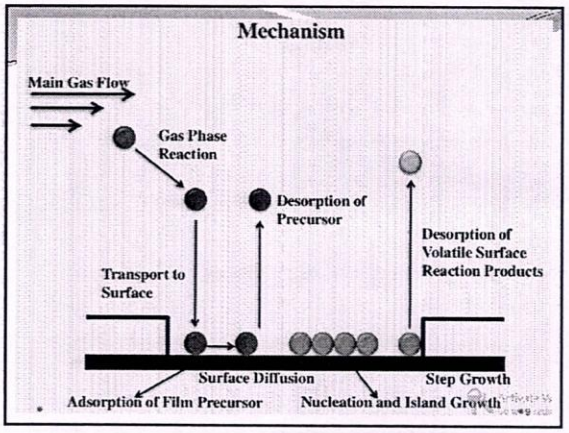
Steps Involved



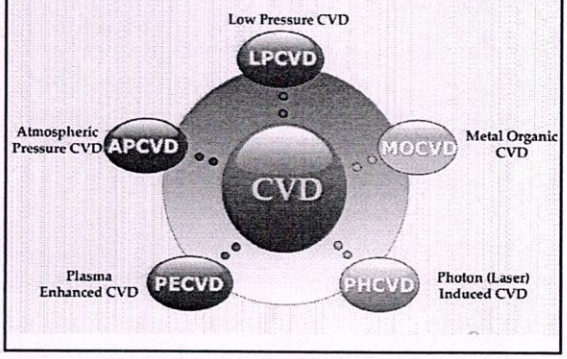
Mechanism



Mechanism



Types



Atmospheric pressure chemical vapour deposition (APCVD)

- It works at atmospheric pressure.
- It is used to deposit a layer of material typically several micrometers thick onto a wafer or other type of substrate.
- It is also used as a surface finishing process for items such as tools and turbine blades to improve lifetime and performance.
- Since a vacuum system is not required, APCVD systems have a relatively low operating cost.
- APCVD has inherently poor utilization.
- APCVD is extremely susceptible to oxidation due to the greater gas density and residence times.

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Low pressure chemical vapour deposition (LPCVD)

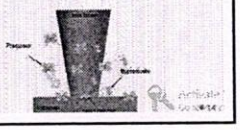
- LPCVD coatings exhibit excellent uniformity, high purity, and good step coverage.
- It works at sub-atmospheric pressures. Reduced pressures tend to reduce unwanted gas-phase reactions and improve film uniformity across the wafer.
- The lower pressure increases the precursor diffusion through the gas and the mass transfer rate of the gaseous reactants becomes higher than the surface-reaction rate.
- The pressure for LPCVD is usually around 10-1000 Pa while standard atmospheric pressure is 101,325 Pa.

Metal-organic chemical vapour deposition (MOCVD)

- Metal-organic compounds are used as molecular precursors to deposit, a wide variety of thin film materials for new industrial applications.
- The great advantage of MOCVD precursors are their high volatility at moderate to low temperatures, therefore reaction temperatures are lower (750 to 1100 K) than conventional CVD.
- The main disadvantages are the precursors tend to be very expensive and are very volatile. When reactive liquids are used they require accurate pressure control and are difficult to purify.

Laser chemical vapour deposition (LCVD)

- LCVD uses a focussed laser beam to heat the substrate.
- It also has the ability to locally heat a part of the substrate while passing the reactant gas, thereby inducing film deposition by locally driving the CVD reaction at the surface.
- It is used to deposit microscale solid patterns or three dimensional structures on the surface of a substrate by a localized, single step process.



Plasma-enhanced chemical vapour deposition (PECVD)

- PECVD is used to deposit SiO_2, Si_3N_4 (Si_xN_y), $Si_xO_yN_z$ and amorphous Si films.
- Plasma can be used to decompose a molecule that will not decompose at a reasonable elevated temperature.
- It can be used to decompose a thermally unstable molecule but at a much lower temperature.
- In plasma CVD substrates that cannot tolerate high temperatures, such as polymers, can be used, where substrate temperatures range from 100 to 500°C.

Advantages

- CVD films are generally quite conformal, i.e., the ability of a film to uniformly coat a topographically complex substrate.
- Versatile –any element or compound can be deposited.
- High purity can be obtained.
- High density – nearly 100% of theoretical value.
- CVD films are harder than similar materials produced using conventional ceramic fabrication processes.
- Material formation well below the melting point.
- Economical in production, since many parts can be coated at the same time.

Disadvantages

- Chemical and safety hazards caused by the use of toxic, corrosive, flammable and/or explosive precursor. Therefore extra steps have to be taken in the handling of the precursors and in the treatment of the reactor exhaust.
- High deposition temperatures (often greater than 600 °C) are often unsuitable for structures already fabricated on substrates.
- Restrictions on the kind of substrates that can be coated.
- It leads to stresses in films deposited on materials with different thermal expansion coefficients, which can cause mechanical instabilities in the deposited films.

Applications

- ✓ Coatings – Coatings for a variety of applications such as wear resistance, corrosion resistance, high temperature protection.
- ✓ Semiconductors and related devices – Integrated circuits, sensors and optoelectronic devices.
- ✓ Fiber optics – for telecommunication.
- ✓ Used in the microelectronics industry to make films serving as dielectrics, conductors, passivation layers, oxidation barriers, and epitaxial layers.

Unit-IV, Chapter-2

NANOTECHNOLOGY

Presented by

Dr. R. Joyce Stella,

KSRMCE, Kadapa

Applications of Nano Materials

Though nanoparticles are very small they are the important materials to build the future world. They have so many applications.

i. Since they are stronger, lighter etc. they are used to make hard metals.
ii. Smart magnetic fluids are used in vacuum seals and magnetic separators.
iii. Orderly assembled nanomaterials are used as quantum eclectic devices and photonic crystals.
iv. Nano materials are used to make CD'S and semi conductor laser.
v. They are used in energy storage devices.
vi. They are used in mobiles. Lap tops and computers.
vii. Recently nanotubs were designed which are used to remove the damaged cancer cells and also to modified the neutron network in human body

APPLICATIONS OF NANOTECHNOLOGY

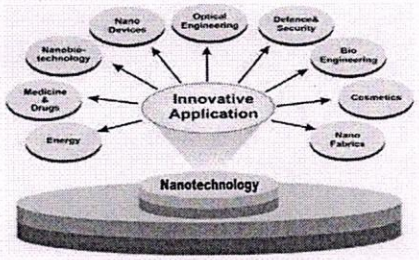
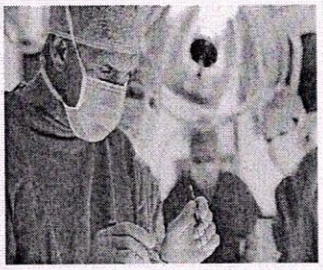


Fig 1. Various applications of nanotechnology

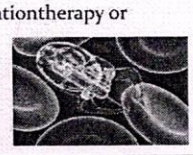
NANOTECHNOLOGY IN MEDICINE

- Medical use of nanomaterials:
  - Drug delivery
  - Cancer
  - Surgery
  - Tissue engineering
  - Visualization



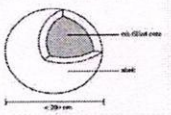
DRUG DELIVERY (CANCER)

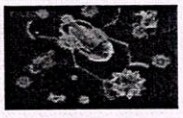
- Enable drugs to be delivered to precisely the right location in body.
- Drug is attached to a nanosized carrier.
- Side-effects can be lowered significantly.
- Reduces cost and human suffering.
- Cancer treatment with iron nanoparticles or gold shells.
- Current treatment is throught radiationtherapy or chemotherapy.



NANOTECHNOLOGY IN MEDICINE

- ANTI -MICROBIAL TECHNIQUES
  - Nanoparticle cream
  - Nanocapsules
  - Cell repairs using nanorobots





NANOTECHNOLOGY ELECTRONICS

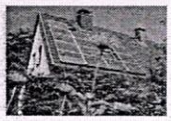
- WAYS OF IMPROVEMENT:
- Allowing more transistors to be packed into a single chip.
- Allows a higher electron mobility .
- A higher dielectric constant (faster frequency).
- Single electron transistors.
- Using electrodes made from nanowires.
- Using nanosized magnetic rings.

NANOTECHNOLOGY IN COMPUTERS

- Computer processors are more powerful.
- Ultra high density memories.
- Silcon transistors are replaced by transistors based on carbon nanotubes.
- Size of the microprocessors are reduced to greater extend
- **Memristor** -material as a future replacement of Flash memory.

ENERGY

- Creating devices smaller than 100 nanometers gives us new ways to capture, store, and transfer energy.
- Increased efficiency of lighting and heating
- Increased electrical storage capacity
- A decrease in the amount of pollution from the use of energy.



SPORTS

- Reducing the rate which air leaks from tennis balls so they keep their bounce longer.
- Golf balls to fly straighter.
- Bowling balls become more durable and have a harder surface.

FOOD

- Nanotechnology is having an impact from how food is grown to how it is packed
- Companies are developing nanomaterials that will make a difference not only in taste of food,but also in safety
- Zinc oxide nanoparticles can be incorporated into plastic packing to block UV rays and provide anti bacterial protection
- Improved strength and stability of plastic packing

Industrial Applications of Nanotechnology

Need of the Nanotechnology in Industries

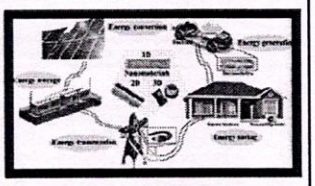
- Nanotechnology has established itself as a key enabling technology for a wide range of applications, thus becoming a top priority for science and technology policy development, being already used in hundreds of products among the industrial sector, namely, electronic, healthcare, chemical, cosmetics, composites and energy.
- Nanomaterials can be used in various industrial applications includes chemical industry, biotechnology related industry, energy related industry, food industries, etc.

Some of the specific applications of Nanomaterials:

- Zinc Oxide: cosmetics, electronics, and pigments
- Copper oxide: electronics, catalysis, and antimicrobial applications
- Magnetite (Iron (II) oxide): magnetic applications, coatings, cosmetics and pigments
- Stannic oxide (tin (IV) oxide: batteries, catalysis, electronics, and sensors
- Anatase (TiO_2): cosmetics, pigments, coatings and photocatalytic applications
- Nano platinum metal supported on activated carbon: electrocatalyst for fuel cells and metal air batteries
- Nano silver metal supported on activated carbon: electrocatalyst for fuel cells and metal air batteries, water treatment, medical and antimicrobial applications.

Energy

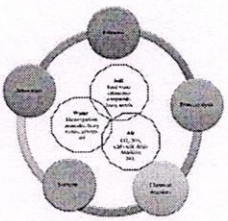
- Solar cells: DSSC, perovskite solar cells, Quantum dot solar cells
- Fuel cells: supercapacitors, Li-ion batteries, etc.,.
- Hydrogen and storage by water splitting techniques
- Photocatalytic activity
- superconductivity
- Nanolubicants, smart windows, nanofrigerants
- Thermoelectric and piezoelectric materials for energy generation



- Nano dusts could be any number of things, like particles of tungsten silicon or photoresist material used in manufacturing process
- The biggest advantage of the material it has is the low cost.
- Oil, is the most important fuel and is known to the world that this resource is limited.
- Metal such as iron, aluminum and boron, have tremendous promise.
- In nanodust form, the mixture of these metals are highly reactive.
- With modified engine and a tank full of metal nanodusts, an average of saloon car could travel three times as far as the equivalent petrol powered vehicle.
- Metal nanofuel is completely nonpolluting because of no carbon oxide, no soot and no nitrogen oxides will be produced.

Pollution control

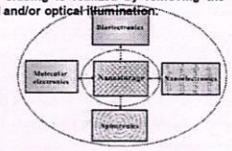
- Iron nanodusts are highly reactive, and they can readily combine with pollutant chemicals and break them down.
- They could reduce the levels of toxic materials at contaminated sites. Laboratory and field tests have shown that they can break down most common pollutants in several hours, such as trichloroethene, carbon tetrachloride, and dioxins.
- They could break down number of pollutants such as pesticides, organic dyes and chlorinated benzenes, albeit relatively slowly.
- Under the right conditions, the metal breaks down water to produce hydrogen, as well as reacting with oxygen to form iron oxide, known as rust.



Data storage

- Nanomaterials, which have unique mechanical, electronic and optical properties owing to the strong confinement of electrons, photons and phonons at the nanoscale, are enabling the development of disruptive methods for optical data storage with ultra-high capacity, ultra-long lifetime and ultra-low energy consumption.

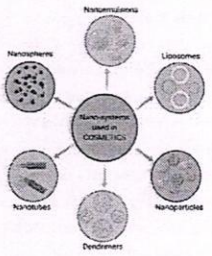
- Molecular electronics - Molecular electronics is one of the most promising nanostorage approaches, which has the potential to replace current semiconductor based information devices
- Nanoelectronics - Nanoparticles, with sub-5 nm dimension, are believed to be one of the most promising materials for ultrahigh density memory devices. For example, nanoparticles covered with insulating layers have been investigated for applications in nonvolatile flash memory devices [168] and electrostatic data storage The principle of the memory device is to inject a number of charges into a single or bundle of nanoparticle embedded in insulator (i.e., WRITE), store the injected charges (STORAGE), and later to sense the stored charges (i.e., READ). The data erasing is realized by removing the stored charges using either reversed electrical field and/or optical illumination.



- Bioelectronics - The advance of nanostorage has a close relationship to the field of bioelectronics. Because one main object of bioelectronics is to find effective ways to develop novel nanoscale devices, building blocks, principles, and technologies for ultrahigh density, low-cost and intelligent information storage systems.
- The basic concept of bioelectronics is to address (electrically, optically, and/or magnetically) a single biomaterial immobilized on substrate. The biomaterials may include proteins, DNA, and enzymes which can be treated as either an organic molecule or nanomaterial. The assembly of these materials can be realized using covalent bond (e.g. Au-thiol), affinity interaction (e.g. charge transfer), and hydrophilic/hydrophobic interaction.

Cosmetics and pigments

- Nanomaterials-based cosmetics show some unique advantages compared to micro-scale cosmetics.
- The use of nanomaterials (NMs) by the cosmetic industry aims for long-lasting effects and increased stability.
- The high surface area of nanomaterials allows for more efficient transport of the ingredients through the skin.
- Some of the main targets of using nanomaterials in cosmetics could be the efficient penetration into the skin for the improved delivery of the ingredients of the product, new color elements (e.g., in lipsticks, and nail polishes), transparency (e.g., in sunscreens), and long-lasting effects (e.g., in makeup).



Liposomes
- Liposomes are concentric bilayered vesicles in which the aqueous volume is entirely enclosed by a lipid bilayer composed of natural or synthetic phospholipids which are GRAS (generally regarded as safe) products. The lipid bilayer of liposomes can fuse with other bilayers such as the cell membrane, which promotes release of its contents, making them useful for cosmetic delivery applications.

Nanoemulsions
- They are dispersions of nanoscale droplets of one liquid within another. They are metastable systems whose structure can be manipulated based on the method of preparation. The components used for their preparation are GRAS products and are safe to use. Their smaller particle size provide higher stability and better suitability to carry active ingredients; they also increase the shelf life of the product.

Nanocapsules
- Nanocapsules are submicroscopic particles that are made of a polymeric capsule surrounding an aqueous or oily core. It has been found that the use of nanocapsules decreases the penetration of UV filter octyl methoxycinnamate in pig skin when compared with conventional emulsions

Nanocrystals
- They are aggregates comprising several hundred to tens of thousands of atoms that combine into a "cluster". Typical sizes of these aggregates are between 10 and 400 nm and they exhibit physical and chemical properties somewhere between that of bulk solids and molecules. They allow safe and effective passage through skin.

Nanoparticles
- They are oily droplets of lipids which are solid at body temperature and stabilized by surfactants. They can protect the encapsulated ingredients from degradation, used for the controlled delivery of cosmetic agents over a prolonged period of time and have been found to improve the penetration of active compounds into the stratum corneum. *In vivo* studies have shown that an SLN-containing formulation is more efficient in skin hydration than a placebo. They have also been found to show UV-resistant properties, which were enhanced when a molecular sunscreen was incorporated and tested. Enhanced UV blocking by 3,4,5-trimethoxybenzoylchitin (a good UV absorber) was seen when incorporated into SLNs.

Dendrimers
- Dendrimers are unimolecular, monodisperse, micellar nanostructures, around 20 nm in size, with a well-defined, regularly branched symmetrical structure and a high density of functional end groups at their periphery. They contain large number of external groups suitable for multifunctionalization.

Hydrogels
- They are 3D hydrophilic polymer networks that swell in water or biological fluids without dissolving as a result of chemical or physical cross-links. They can predict future changes and change their property accordingly to prevent the damage.

- Titanium Dioxide is used as an inorganic white pigment for paper, paints, plastics, and whitening agents.
- TiO2 nanoparticles are used as UV blocking pigments in sunscreens, cosmetics, varnishes, and fabrics.
- Zinc Oxide has opaque and antifungal properties.
- Used as UV blocking pigments in sunscreens, cosmetics, varnishes, and fabrics

Sensors

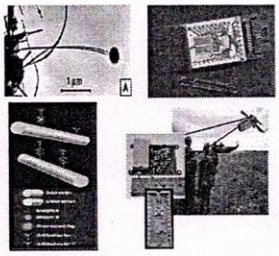
- "Nanosensors are chemical or mechanical sensors that can be used to detect the presence of chemical species and nanoparticles, or monitor physical parameters such as temperature, on the nanoscale." They find use in medical diagnostic applications, food and water quality sensing, and other chemicals."
- Sensors operating on the scale of atoms and molecules
- Smaller size, lower weight, modest power requirements
- Data storage systems

Nanosensors include:

- Carbon Nanotube–Based Fluorescent Nanosensors
- Quantum Dot–Based Fluorescent Nanosensors
- DNA-Based Fluorescent Nanosensors
- Peptide-Based Fluorescent Nanosensors
- Plasmon Coupling–Based Nanosensors
- Plasmonic Enhancing–/Quenching–Based Nanosensors
- Magnetic Resonance Imaging-Based Nanosensors
- Photoacoustic-Based Nanosensors
- Multimodal Nanosensors (synergistic nanosensors with multiple modalities to overcome individual challenges)

13

- Physical Sensors - World's smallest balance
- Chemical sensors - Ionization detector, Wireless sensor network
- Biosensors - Detection of complex molecules
- Deployable Nanosensors - SnifferSTAR a light- weight portable chemical detection system
- Nanonose
- Nanothermometer
- NanoParticles spy on molecular binding
- Gas sensors
- Detection of heavy metal ions with a nanocontact sensor



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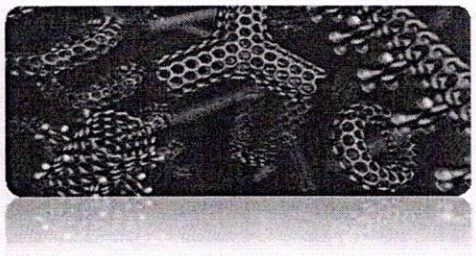
PHY1701 Dr. Ajitha

Carbon Nanotubes (CNT)



What is a Carbon Nanotube?

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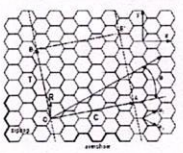
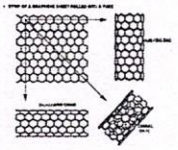
- CNT is a tubular form of carbon with diameter as small as 1nm.
- Length: few nm to microns.
- CNT is configurationally equivalent to a two dimensional graphene
- sheet rolled into a tube.
- A CNT is characterized by its Chiral Vector: $C_h = n\,\hat{a}_1 + m\,\hat{a}_2$,
- $\theta \rightarrow$ Chiral Angle with respect to the zigzag axis.





Why do Carbon Nanotubes form?

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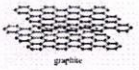
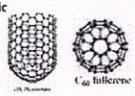
Carbon ——— Graphite (Ambient conditions)
sp^2 hybridization: planar



Diamond (High temperature and pressure)
sp^3 hybridization: cubic

Nanotube/Fullerene (certain growth conditions)
$sp^2 + sp^3$ character: cylindrical



Finite size of graphene layer has dangling bonds. These dangling bonds correspond to high energy states.

Nanotube formation — Eliminates dangling bonds + Increases Strain Energy → Total Energy decreases

Types of CNTs

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- Single Wall CNT (SWCNT)
- Multiple Wall CNT (MWCNT)
- Can be metallic or semiconducting depending on their geometry.

Carbon Nanotubes Properties

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- CNTs have high thermal conductivity
- CNTs have high electrical conductivity
- CNTs aspect ratio
- CNTs are very elastic ~18% elongation to failure
- CNTs have very high tensile strength
- CNTs are highly flexible — can be bent considerably without damage
- CNTs have a low thermal expansion coefficient
- CNTs are good electron field emitters

Biomedical Applications

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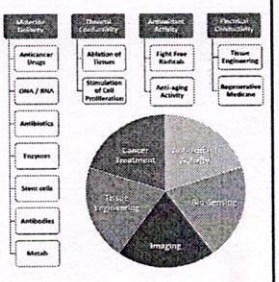
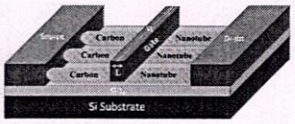
- **CNT is used in bio-medicine, specifically bio-sensing, diagnostics, and therapy. This was facilitated by the excellent ability of CNTs to act as carriers of molecules of different origin, including proteins, DNA/RNA, enzymes, and drugs.**
- **CNTs are capable of effectively by-passing the blood–tissue barrier and penetrating cells.**
- **The huge surface area and excellent ability to penetrate the cell membrane make CNTs a perfect platform for delivery pharmacological and genetic compounds into the cells in cancer treatment**



Electrical, Molecular device applications

Carbon nanotubes have unique properties that make them a most promising system on which to base molecular electronics.

- **Field-Effect Transistors**
- **Ambipolar and n-Type Carbon Nanotube Transistors**
- **Carbon Nanotube Transistor Arrays**
- **Carbon Nanotube Integrated Circuits: Logic Gates**



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- In any electronic circuit, but specifically when dimensions reduce in size to the nanoscale, the interconnections between switches and other active devices become more and more essential. Their ability to be precisely derived, electrical conductivity, and geometry make CNTs the most suitable candidates for the connections in molecular electronics.
- The exact properties that make CNTs desirable as conductive fillers for use in ESD materials, electromagnetic shielding, and so on make them suitable for interconnection applications and electronics packaging, including coaxial cables, potting compounds, and adhesives and other types of connectors.
- CNTs can carry an amazingly high current density, probably as high as 10^{13} A/cm^2. CNTs are the best known field emitters of any material, with regard to their high electrical conductivity.

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