Ph.D COURSE WORK

15PHCW01 – THIN FILMS

Unit – I Introduction

Thin films an overview – Film growth stages – Nucleation – Island structure – Coalescence – Channel and continuous film – crystal structure – crystal lattice and unit cell – Crystal planes and Miller indices – Crystal system and symmetry – Interplanar spacing.

Unit - II Thin Film Deposition Techniques

Thin Films – Introduction to Vacuum Technology – Deposition Techniques – Physical Methods – Resistive Heating, Electron Beam Gun, Laser Gun Evaporation and Flash Evaporations, Sputtering – Reactive Sputtering, Radio-Frequency Sputtering – Chemical Methods – Spray Pyrolysis – Preparation of Transparent Conducting Oxides – Applications.

Unit - III Fabrication

Physical vapour deposition – Thermal evaporation – Electron beam evaporation-Molecular beam epitaxy – Sputtering techniques – Pulsed laser deposition – Chemical vapour deposition: – Spray pyrolysis – Chemical bath deposition – Electro chemical deposition – Sol – gel technique – Spin coating – SILAR method.

Unit - IV Characterization Techniques

X – Ray Diffraction (XRD) – Powder and single crystal – Fourier transform Infrared analysis (FT-IR) – Elemental analysis – Elemental dispersive X-ray analysis (EDAX) – Scanning Electron Microscopy (SEM) – UV-Vis-NIR Spectrometer – Vickers Micro hardness.

Unit - V Applications

Discrete resistive components – Thermistor, Strain gauge element – Capacitor – Hall probe element – Active devices – Micro electronics, Integrated circuits and other applications – Interference filters – Anti – reflection coatings – Thin film gas sensors – Solar cell applications.

Books for Study and Reference:

1. A. Goswami, Thin film Fundamental, New Age International (P) Ltd, New Delhi (2006).
2. M.Ohring, Materials Science of Thin Films (Academic press, Boston, 2002) 2nd edition.
3. Fundamentals of surface and thin film analysis – Leonard C. Feldman and James W. Mayer.

Ph.D COURSE WORK

15PHCW02 – MATERIALS SCIENCE

Unit - I Chemical Bonds

Review of Atomic structure – Interatomic Forces – Different types of chemical bonds – Ionic covalent bond or homopolar bond – Metallic bond – Dispersion bond – Dipole bond – Hydrogen bond – Binding energy of a crystal – Elastic properties.

Unit - II Modern Engineering Materials

Classification of Polymers – Ceramics – Super strong materials – Cermets – High temperature materials – Thermo electric materials – Electrets – Nuclear engineering materials.

Unit - III Non Destructive Testing:

Radiographic methods – Photo elastic method – Electrical methods – Ultrasonic methods Surface defect detection by NDT – Equipments used in non destructive testing – Metallurgical microscope – Election microscope – Coolidge x-ray tube – Production of ultrasonic waves – Magnetostriction Ultrasonic generator – Piezo electric ultrasonic generator.

Unit - IV New Materials

Metallic glasses – Fiber reinforced plastics – Metal matrix composites – Material for optical sources and detectors – Fiber optic materials and their applications – Display materials – Acoustic materials and their applications – SAW materials – Biomaterials – High temperature superconductors.

Unit - V Mechanical Behavior of Materials

Different mechanical properties of Engineering materials – Creep – Fracture – Technological properties – Factors affecting mechanical properties of a material – Heat treatment – cold and hot working – Types of mechanical tests – metal forming process – Elastic after effect – Deformation of crystals and poly crystalline materials.

Books for Study and Reference:

1. Materials Science by M.Arumugam, Anuradha Publishers. 1990 Vidayalkaruppur, Kumbakonam.

2. Materials Science and Engineering V.Raghavan Printice Hall India Ed. V 2004. New Delhi.

15PHDPHI **Credit 4**

Ph.D - Course work-Paper I
RESEARCH METHODOLOGY

Unit I: Research Methodology

Introduction – meaning of Research, Scientific method, research process and bias– Hypothesis, theory and scientific writing.

Types of research – Steps in research – Identification, Selection and formulation of research problem – Research questions – Research design – Formulation of Hypothesis.

Unit II: Techniques for Research:

Identification of the problem – determining mode of attack – literature survey – references - awareness of current status of the art – abstraction of a research paper – possible ways of getting abreast current literature – role of scholar and guide.

Unit III: Techniques of Scientific Writing:

Scientific writing – definition – organizing a scientific paper – Title – Listing of authors and address – abstract – introduction – material and methods section – results section – discussion section – acknowledgement – references – effective illustration - designs of effective tables and figures-references and appendixes – revision and completion of the manuscript – final touch – Bibliography.- – submission – review process – publishing process – reprints – review paper – conference report – oral and poster presentation – thesis – usage of English.

Unit IV: Data Analysis

Introduction – Statistical description of data - Mean , variance, skewness, median, mode – Distributions – Student's t-test, F-test, Chi-square test – Linear and rank correlations – Modelling data: Least-squares, Fitting data.

Unit V: Numerical Method

1. **Solving Linear simultaneous equation:** Gauss Elimination method – Gauss – Jordan method – Gauss – Seidel method.
2. **Solving Nonlinear equation:** The Bisection method – iteration method – Newton – Raphson method.
3. **Interpolation:** Linear interpolation – Lagrange interpolation – Newton interpolation – Divided difference table – Interpolation with equidistant points-line interpolation.

Books for Study:

1. A. Singaravelu, Numerical Methods, Meenakshi Agency, Chennai(2003)
2. How to write and publish a scientific paper (4^{th} edn), Robert A. Day
3. Numerical Computational Methods, P.B. patil, U P. Verma, (Narosa, New Delhi, 2006)
4. Research Methodology Methods and Techinques – C.R. Kothari.
5. P. Kandasamy, K. Thilagavathy, Numerical Methods, S.Chand. New Delhi, 2007.
6. Computational Physics: An introductory course. Richard Fitzpatrick.
7. H. K. Dass, *Mathematical Physics*, S. Chand & Company, New Delhi (2003).

8. C.R. Kothari, *Research methodology: Methods and Techniques*, (New age International, New Delhi, 2006).

Sub.Code:15PHDPH2 **Credit: 4**

Ph.D - Course work-Paper II

Thin Films and their Applications

Unit I - Introduction

Thin films an overview – Film growth stages- Nucleation stage - Island structure stage- Coalescence stage- Channel stage and continuous film stage -crystal structure –crystal lattice and unit cell – Crystal planes and Miller indices – Crystal system and symmetry- Interplaner spacing.

Unit II -Fabrication

Physical vapour deposition –Thermal evaporation – Electron beam evaporation- Molecular beam epitaxy – Sputtering techniques – Pulsed laser deposition - Chemical vapour deposition: – Spray pyrolysis – Chemical bath deposition - Electro chemical deposition – Sol–gel technique – Spin coating- SILAR method.

Unit – III Structural and Electrical studies

X-ray diffraction- Powder diffraction technique for polycrystalline thin films-Structural parameters.

Electrical resistivity- Sheet resistance - Valde's formula for sheet resistance Four probe method- Hot probe method for the determination of type of conductivity - Hall probe method to find mobility, Carrier concentration and resistivity.

Unit –IV Optical, Surface and Magnetic studies

UV-vis-NIR spectrophotometer- Transmission and absorption spectra of thin films- Optical band gap - absorption co-efficient-SEM- AFM-TEM- EDS–XPS- PL spectra- Thickness measurement- Weight gain method- surface profilometer- optical interference method – multiple beam interferometry – ellipsometry-Fizeau method- Magnetic properties of thin films- VSM-SQUID.

Unit –V Applications

Discrete resistive components- Thermistor, Varistor, Strain gauge element- Capacitor-Hall probe element- Active devices- Micro electronics, Integrated circuits and other applications-Interference filters- Anti -reflection coatings- Thin film gas sensors- Solar cell- photocatalytic and antibacterial applications.

References:

1.Thin film fundamentals- A. Goswami,New Age international pvt .Ltd, New Delhi 1996

2. Materials science process technology series- Rointan F. Bunshah, Noyes publications USA 1994

3. Elements of X-ray diffraction- B. D. Cullity,Addition – Wesley Publishing Company, Inc. USA,1956

4.Introduction to thin films- K. Ravichandran, K. Swaminathan, B. Sakthivel, Research India Publications, New Delhi, 2013

Sub.Code:15PHDPH3 **Credit: 4**

Ph.D - Course work-Paper III

Nanotechnology

Unit I - Introduction

Nanomaterials- Characteristic of nanomaterials-Effect of surface area to volume ratio on the properties of nanomaterials- Application of nanomaterials- various nanostructures- Nanomaterials- Nanoparticles- Nanowire- Nanocomposite- Nanoclusters and Quantum dots.

Unit- II- Carbon Nano Tubes (CNT)

Introduction to CNT- SWNT-MWNT- Synthesis of carbon nanotubes: Plasma arc – discharge method- Laser- Ablation technique-Chemical vapour deposition - Growth mechanism- Properties- CNT based Nano objects- Gaseous carbon source based production techniques for CNT- Applications.

Unit- III- Fabrication

Top –Down Techniques: Ball milling-Combustion synthesis-Nanolithography- Bottom up techniques: self assembly- Hydrothermal method – sol-gel synthesis – Gas condensation – Co- precipitation method - Polyol process –Sonochemical process.

Unit- IV- Characterization

Scanning Probe Microscopy - Principle of operation – Instrumentation- Scanning Tunneling Microscopy- STM probe construction and measurement – Atomic Force Microscopy- Instrumentation and Analysis- Tunneling Electron Microscopy- operation and measurement.

Unit – V – Photocatalytic and their Applications

Photocatalysis- types of photocatalysis: homogeneous photocatalysis- heterogeneous photocatalysis- Application of photocatalysis- Semiconductor photocatalytic materials – TiO_2, ZnO_2 – semiconductor/ graphene derivative nanocomposite as visible light responsive photocatalysts- photoreactor experiment-various types of photoreactor.

References:

1. Hand book of Nanotechnology- Bharat Bhushan, Springer 3rd ed. 2010

2. Nanotechnology and Nanoelectronics – W. R. Fahrner (Editor), Springer (India) Pvt.Ltd,2006

3. Nanotechnology- Mark Ratner, Daniel Ratner, Prentice Hall Professional 2003

Ph.D COURSE WORK

16PHCW01 – NANOSCIENCE AND TECHNOLOGY

Unit – I Background to Nanotechnology

Scientific revolution – Atomic structures – Molecular and atomic size – Bohr radius – Emergence of Nanotechnology – Challenges in Nanotechnology – Carbon age – New form of carbon.

Unit – II Synthesis of Nanomaterials

Nanomaterials – Preparation – Plasma arcing – Electron beam lithography – Chemical vapour deposition – Sol gels – Electrochemical deposition – Dry and Wet etching – Ball milling – Top-down and Bottom-up approaches.

Unit – III Properties of Nanomaterials

Carbon Nanotubes (CNT) – Carbon Fullerences – Metals (Au, Ag) – Metal oxides (TiO2, CeO2, ZnO) – Semiconductors (Si, Ge, CdS, ZnSe) – Ceramics and Composites – Dilute magnetic semiconductor – Size dependent properties – Mechanical, Physical and Chemical properties.

Unit – IV Characterization of Nanoscale Systems

Structural characterization: SPM, XRD, BET, TEM, SEM, Nanotweezers electron microscopy. Optical characterization: UV – Vis – Fluorescence – Raman and IR – XPS and Auger spectroscopy.

Unit – V Applications of Nanomaterials

Overview of nanomaterials applications – Molecular electronics and nanoelectronics – Quantum electronic devices – CNT based transistor and Field Emission Display – Nanomechanics – Photonics - Biological applications – Biochemical sensor – Membrane based water purification.

Books for Reference:

1. M. Wilson, K. K. G. Smith, M. Simmons, B. Ragase, Nanotechnology, Overseas Press India Pvt, Ltd, New Delhi, First Edition, 2005.

2. M.Ratner.et al., Nanotechnology; A Gentle introduction, Prentice – Hall ISBN 0-13-101400-5, 2003.

Ph.D COURSE WORK

16PHCW02 – ADVANCED MATERIALS

Unit – I Modern Engineering Materials

Metallic glasses: Preparation – Properties and Applications – Shape memory alloys (SMA): Characteristics – Properties – Applications – Advantages and disadvantages.

Unit – II Smart Materials

The principal ingredients of smart materials – Thermal materials – Sensing technologies – Microsensors – Synthesis of future smart systems – Pyroelectricity – Piezoelectricity – Properties of commercial piezoelectric materials – Smart materials featuring piezoelectric elements.

Unit – III Ceramic and Composite Materials

Advanced Ceramic Materials – Crystal Structures – Silicate Ceramics – Glasses – Glass ceramics – Functional properties and applications of ceramic materials – Classification of composites – Fiber reinforced materials – Law of mixtures – Continuous fibers – discontinuous fibers – Application of composites in electrical and mechanical components and in nuclear industry.

Unit– IV Polymer Materials

Classification of polymer – Mechanism of polymerisation – Some commercially important individual polymer – Thermoplastics – Elastomers – Thermosets – Engineering plastics – Liquid crystal polymers – Conductive polymers – High performance fibers – Biomedical applications – Photonic polymers.

Unit – V Superconducting Materials

Superconductivity: properties – Types of super conductors – BCS theory of superconductivity – High Tc superconductors – Applications of superconductors – SQUID, Cryotron, Magnetic levitation.

Books for Reference:

1. William D. Callister, Jr., Materials Science and Engineering an Introduction, 2/e Edition, John Wiley & Sons, Inc., 2007.

2. M.V. Gandhi and B.S. Thompson, Smart materials and structures, chapman and Hall, London, First Edition, 1992.

SUB. CODE: 16PHDPH1 Ph.D. COURSE WORK PAPER - I Credit: 4

CRYSTAL GROWTH PROCESSES AND TECHNIQUES

UNIT -1 INTRODUCTION TO CRYSTAL GROWTH AND NANO PHYSICS

Growth of single crystals-semiorganic crystals– reasons for growing single crystals – crystal growth techniques – introduction to nano physics - nano powders - nano materials - types-synthesis - applications**.**

UNIT – II NUCLEATION AND KINETIC THEORY OF CRYSTAL GROWTH

Introduction – theories of nucleation – classical theory – Gibb's Thomson equation for solution – Energy formation of a nucleus – spherical nucleus – cylindrical nucleus – nucleation rates – Homogenous and heterogeneous nucleations – Kinetic of crystal growth – introduction – Kossel, Stranski, Volume– BCF theory of solution growth.

UNIT – III MELT GROWTH

Bridgeman - stockbarger techniques – Vernouil method – Zone melting method – Distribution of impurity concentration – Matter transport during Zone melting – Czochralski techniques – thermal convection of CZ melts.

UNIT – IV CRYSTALLIZATION FROM SOLUTION AT LOW TEMPERATURE

Introduction – basic requirements – choice of solvent – crystal habit – solubility – saturation and seeding – crystallization apparatus – seed selection and mounting – factors that influence the perfection of the final crystal – control of crystal morphology – super saturation **and metastability – measurements of super saturation.**

UNIT – V GEL AND UNIDIRECTIONAL GROWTH

Gel growth: Principle – structure and properties – types – periodic crystallization – biological crystallization – advantage and disadvantages

Unidirectional growth: Sankaranaryanan – Ramasamy method – significance of unidirectional growth – experimental set up – advantages.

REFERENCES:

1. Santhlana Ragavan.P and Ramasamy.P Crystal growth processes and methods, Kru publications, 2000.
2. Hand book of Nanotechnology- Bharat Bhushan, Springer 3rd ed. 2010
3. Buckley, H. Crystal Growth, Wiley, New York, 1951.
4. Lawson, W.D. and Nielson,S. Preparation of Single Crystals, Butterworths, London, 1958.
5. Holden, A. and Singer, P. Crystals and Crystal Growing, Anchor – Doubleday, New York, 1960.
6. Hurel,D.T.J. Mechanisms of Growth of Metal Single Crystals from the Melt, Prog. in Mat.Sci. Vol. 10, Pergamon Press, Oxford, 1962.
7. Henisch, H.K. Crystal Growth in Gels, Penn. State Univ.Press, 1970.

SUB.CODE: 16PHDPH2 Ph.D. COURSE WORK PAPER - II Credit: 4

ADVANCED CHARACTERISATION STUDIES

UNIT – I STRUCTURAL ANALYSES

X-ray diffraction – Bragg's equation – methods in X-ray crystallography – powder diffractometer – recording and interpretation of powder patterns – single crystal XRD techniques – Laue method – rotation photography method – oscillation method – intensities of diffracted X-rays and structural analysis.

UNIT – II OPTICAL AND SPECTRAL ANALYSES

UV and visible spectroscopy: – introduction – absorption laws – measurement of absorption intensity – theory of electronic spectroscopy – types of electronic transitions – types of absorption bands – Instrumentation.

IR Spectroscopy: Principle of infra–red spectroscopy – applications – basic principles of FTIR spectroscopy – instrumentation – Laser Raman spectroscopy – working principle and instrumentation- SEM-TEM -atomic force microscopy

UNIT – III MECHANICAL ANALYSES

Hardness – definition – types of hardness tests – micro hardness tests – Vickers and Knoop hardness tests – hardness conversion – precautions – relative merits and demerits – applications.

UNIT – IV THERMAL ANALYSES

Introduction – thermo gravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA) – cooling curves – differential scanning calorimeter (DSC) – instrumentation – analysis of DSC curves.

UNIT – V NONLINEAR OPTICAL STUDIES

Theory and application of nonlinear optical effects – frequency conversion – optical switching – phase conjugation – optical bistability – nonlinear optical materials.

Kurtz and Perry Powder technique – basic principles – instrumentations – introduction to third harmonic generation – Z scan technique – principles – instrumentation – double refraction – significance – Laser damage threshold – experimental set up – applications.

REFERENCES:

1. Ueda, R. and Mullin, J.B. Crystal Growth and Characterization, North-Holland, Amsterdam, 1975.
2. Nanotechnology- Mark Ratner, Daniel Ratner, Prentice Hall Professional 2003
3. Straddling, R.A; Klipstain, P.C; Growth and characterization of semiconductors, Adam Hilger, Bristol, 1990.
4. Sangwal, K. and Rodriguez-Clemente, R. (1991) Surface Morphology of Crystalline Materials, Trans Tech Pub. Sitzerland.
5. Y.R. Sharma, Elementary organic spectroscopy,2002.
6. Brain Keith Tanner, David Keith Bowen, Characterization of Crystal Growth Defects by X-Ray Methods,1980.

Ph.D COURSE WORK

17PHCW01 – THIN FILMS

Unit – I Introduction

Thin films an overview – Film growth stages – Nucleation – Island structure – Coalescence – Channel and continuous film – crystal structure – crystal lattice and unit cell – Crystal planes and Miller indices – Crystal system and symmetry – Interplanar spacing.

Unit - II Thin Film Deposition Techniques

Thin Films – Introduction to Vacuum Technology – Deposition Techniques – Physical Methods – Resistive Heating, Electron Beam Gun, Laser Gun Evaporation and Flash Evaporations, Sputtering – Reactive Sputtering, Radio-Frequency Sputtering – Chemical Methods – Spray Pyrolysis – Preparation of Transparent Conducting Oxides – Applications.

Unit - III Fabrication

Physical vapour deposition – Thermal evaporation – Electron beam evaporation-Molecular beam epitaxy – Sputtering techniques – Pulsed laser deposition – Chemical vapour deposition: – Spray pyrolysis – Chemical bath deposition – Electro chemical deposition – Sol – gel technique – Spin coating – SILAR method.

Unit - IV Characterization Techniques

X – Ray Diffraction (XRD) – Powder and single crystal – Fourier transform Infrared analysis (FT-IR) – Elemental analysis – Elemental dispersive X-ray analysis (EDAX) – Scanning Electron Microscopy (SEM) – UV-Vis-NIR Spectrometer – Vickers Micro hardness.

Unit - V Applications

Discrete resistive components – Thermistor, Strain gauge element – Capacitor – Hall probe element – Active devices – Micro electronics, Integrated circuits and other applications – Interference filters – Anti – reflection coatings – Thin film gas sensors – Solar cell applications.

Books for Study and Reference:

1. A. Goswami, Thin film Fundamental, New Age International (P) Ltd, New Delhi (2006).
2. M.Ohring, Materials Science of Thin Films (Academic press, Boston, 2002) 2nd edition.
3. Fundamentals of surface and thin film analysis – Leonard C. Feldman and James W. Mayer.

Ph.D COURSE WORK

17PHCW02 – MATERIALS SCIENCE

Unit - I Chemical Bonds

Review of Atomic structure – Interatomic Forces – Different types of chemical bonds – Ionic covalent bond or homopolar bond – Metallic bond – Dispersion bond – Dipole bond – Hydrogen bond – Binding energy of a crystal – Elastic properties.

Unit - II Modern Engineering Materials

Classification of Polymers – Ceramics – Super strong materials – Cermets – High temperature materials – Thermo electric materials – Electrets – Nuclear engineering materials.

Unit - III Non Destructive Testing:

Radiographic methods – Photo elastic method – Electrical methods – Ultrasonic methods Surface defect detection by NDT – Equipments used in non destructive testing – Metallurgical microscope – Election microscope – Coolidge x-ray tube – Production of ultrasonic waves – Magnetostriction Ultrasonic generator – Piezo electric ultrasonic generator.

Unit - IV New Materials

Metallic glasses – Fiber reinforced plastics – Metal matrix composites – Material for optical sources and detectors – Fiber optic materials and their applications – Display materials – Acoustic materials and their applications – SAW materials – Biomaterials – High temperature superconductors.

Unit - V Mechanical Behavior of Materials

Different mechanical properties of Engineering materials – Creep – Fracture – Technological properties – Factors affecting mechanical properties of a material – Heat treatment – cold and hot working – Types of mechanical tests – metal forming process – Elastic after effect – Deformation of crystals and poly crystalline materials.

Books for Study and Reference:

1. Materials Science by M.Arumugam, Anuradha Publishers. 1990 Vidayalkaruppur, Kumbakonam.

2. Materials Science and Engineering V.Raghavan Printice Hall India Ed. V 2004. New Delhi.

PH.D COURSE WORK

18PHCW01 – NANOTECHNOLOGY

Unit -I Introduction to Nanotechnology

Introduction to Nanotechnology – Types of nano technology – Nano structures – Types – Properties – Applications.

Unit -II Synthesis of Nanomaterials

Nanomaterials preparation types – Top down & Bottom up approaches – Hydrothermal synthesis – Solvothermal method – Chemical vapor deposition (CVD)
– Pulsed laser ablation – SOL gel method – Electrochemical deposition – Spray pyrolysis

Unit –III Characterization Techniques

X – ray diffraction (XRD), SEM, EDAX, TEM, Elemental mapping, FTIR, UV-Visible Spectrophotometer, Differential thermal analyzer (DTA), Thermo gravimetric analysis (TGA), X-Ray photoelectron spectroscopy (XPS).

Unit -IV Nano Electronics

Introduction nanoelectrical and electronic devices – Advantages – Electronic circuit chips – Nano sensors – nanofibers - Application

Unit -V Applications of Nanomaterials

Introduction – Nanomedicine – Diagnostics - Imaging – sensing – blood purification – Tissue Engineering - Medical Devices - Drug delivery – cancer – nanonephrology- Limitations of nanotechnology.

References

[1] Charles P Poole and Frank J Owens, Introduction to Nanotechnology, Wiley publishing limited.

[2] PW.N.Chang, Nanofibers Fabrication, Performance and Applications, Nova Science Publishers Inc., (2009).

[3] Alain Nouailhat, An Introduction to Nanoscience and Nanotechnology, Johnwiley & sons (2006).

[4] T. Pradeep, Nano: The Essentials, Tata McGraw-Hill publishing company limited.

PH.D COURSE WORK

18PHCW02 – NEW MATERIALS

Unit - I Introduction

Introduction – classification of perovskites – Organic Oxide perovskites - Inorganic Oxide Perovskites - Halide Perovskites – Examples of Perovskites - structure – Applications.

Unit – II Methods of Perovskite Synthesis

Solid-state reactions - Gas phase preparations - Wet chemical methods (solution preparation) - Precipitation method - Thermal treatment - Doping of perovskites – Limitations of perovskites.

Unit – III Characterization of Perovskites

Structural Characterization: XRD – SEM – TEM – BET, Optical Characterization: UV Visible spectroscopy – FTIR – XPS - Thermal analysis.

Unit- IV Properties of Perovskites

Optical properties – Dielectric properties - Electrical conductivity – super conductivity – Ion conductivity - Ferromagnetic property – Piezoelectricity - Catalytic property.

Unit – V Applications of Perovskites

Photovoltaics – Lasers - Light-emitting diodes – Photo electrolysis - Gas Sensors - Neurotransmitters sensor - Glucose sensor – Catalyst - Solid oxide fuel cells.

References

[1] A.S. Bhalla, R. Guo and R. Roy, The perovskite structure – a review of its role in ceramic science and technology, Mat. Res. Innovat. 4, 3-26 (2000).

[2] Wells, (1995) Structural Inorganic Chemsitry, Oxford Science publications.

[3] U. Müller, (1993). Inorganic Structural Chemistry, Wiley & Sons Ltd.

[4] A. Navrotsky (1998). "Energetics and Crystal Chemical Systematics among Ilmenite, Lithium Niobate, and Perovskite Structures". Chem. Mater. 10 (10): 2787.

Sub.Code:18PHDPH3 Credit: 4

Ph.D - Course work-Paper III
Nanotechnology

Unit I - Introduction

Nanomaterials- Characteristic of nanomaterials-Effect of surface area to volume ratio on the properties of nanomaterials- Application of nanomaterials- various nanostructures-Nanomaterials- Nanoparticles- Nanowire- Nanocomposite- Nanoclusters and Quantum dots.

Unit- II- Carbon Nano Tubes (CNT)

Introduction to CNT- SWNT-MWNT- Synthesis of carbon nanotubes: Plasma arc – discharge method- Laser- Ablation technique-Chemical vapour deposition - Growth mechanism- Properties- CNT based Nano objects- Gaseous carbon source based production techniques for CNT- Applications.

Unit- III- Fabrication of nanomaterials

Top –Down Techniques: Ball milling-Combustion synthesis-Nanolithography- Bottom up techniques: self assembly- Hydrothermal method – sol-gel synthesis – Gas condensation – Co- precipitation method - Polyol process –Sonochemical process.

Unit- IV- Characterization

Scanning Probe Microscopy - Principle of operation – Instrumentation- Scanning Tunneling Microscopy- STM probe construction and measurement – Atomic Force Microscopy- Instrumentation and Analysis- Tunneling Electron Microscopy- operation and measurement.

Unit – V – Applications of nanomaterials

Various nano structures for gas sensing applications: Zero dimentional one dimentional and two dimentional nano structures - Nano materials for sensors: CNTs, Nanowires, Nanotubes, Nanorods, colloidal silver and gold nano particles- nanocomposites- Applications - Photocatalysis- Semiconductor photocatalytic materials – TiO_2, ZnO_2 – semiconductor/ graphene derivative nanocomposite as visible light responsive photocatalysts

References:

1. Hand book of Nanotechnology- Bharat Bhushan, Springer 3rd ed. 2010
2. Nanotechnology and Nanoelectronics – W. R. Fahrner (Editor), Springer (India) Pvt.Ltd,2006
3. Nanotechnology- Mark Ratner, Daniel Ratner, Prentice Hall Professional 2003
4. S.Yang and P.Shen: "Physics and Chemistry of Nanostructured Materials", Taylor & Francis, 2000.

Doctoral Committee Members

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2. Dr. S. MURUGAN, Research Advisor, Assistant Professor of Physics, A.V.C. College (Autonomous), Mannampandal-609 305, T.N.
3. Dr. A.T. [illegible], Asst. Professor of Phys[illegible], Milton Nursing College, Karur.

Sub.Code:18PHDPH2 **Credit: 4**

Ph.D - Course work-Paper II
Thin Films and their Applications

Unit I - Introduction

Thin films an overview – Film growth stages- Nucleation stage - Island structure stage- Coalescence stage- Channel stage and continuous film stage -crystal structure –crystal lattice and unit cell – Crystal planes and Miller indices – Crystal system and symmetry- Interplanar spacing.

Unit II -Fabrication of Thin Films

Physical vapour deposition –Thermal evaporation – Electron beam evaporation- Molecular beam epitaxy – Sputtering techniques – Pulsed laser deposition - Chemical vapour deposition: – Spray pyrolysis – Chemical bath deposition - Electro chemical deposition – Sol–gel technique – Spin coating- SILAR method.

Unit – III Structural and Electrical studies

X-ray diffraction- Powder diffraction technique for polycrystalline thin films- Structural parameters.

Electrical resistivity- Sheet resistance - Valde's formula for sheet resistance- Four probe method- Hot probe method for the determination of type of conductivity - Hall probe method to find mobility, Carrier concentration and resistivity.

Unit –IV Optical, Surface and Magnetic studies

UV-vis-NIR spectrophotometer- Transmission and absorption spectra of thin films- Optical band gap - absorption co-efficient-SEM- AFM-TEM- EDS–XPS- PL spectra- Thickness measurement- Weight gain method- surface profilometer- optical interference method – multiple beam interferometry – ellipsometry-Fizeau method- Magnetic properties of thin films- VSM-SQUID.

Unit –V Applications

Gas sensors-Sensing mechanism-Important features of gas sensors- Detection Principles and requirements-Various types of sensors- General approach to semiconductor metal oxide gas sensors- Choice of materials sensing - Criteria for the choice of materials- Sensitivity, stability, selectivity and activity- Mechanism behind change in resistance- Oxidising gas and Reducing gas.

References:

1.Thin film fundamentals- A. Goswami,New Age international pvt .Ltd, New Delhi 1996

2. Materials science process technology series- Rointan F. Bunshah, Noyes publications USA *1994*

3. Elements of X-ray diffraction- B. D. Cullity,Addition – Wesley Publishing Company, Inc. *USA,1956*

4.Introduction to thin films- K. Ravichandran, K. Swaminathan, B. Sakthivel, Research India Publications, New Delhi, 2013

5. Sensors: Principles and applications. Peter Hauptmann, Prentice Hall

Doctoral Committee Members

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2.

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A.V.C. College (Autonomous),
Mannampandal-609 305, T.N.

3.

Dr. A.T. Ravichandran
Asst. Professor of Physics
A.V.C. College (Autonomous)
Mannampandal

Ph.D COURSE WORK

19PHCW01 - ADVANCED MATERIALS

UNIT- I SMART MATERIALS

The principal ingredients of smart materials – Thermal materials – Sensing technologies – Microsensors – Synthesis of future smart systems – Pyroelectricity – Piezoelectricity – Properties of commercial piezoelectric materials – Smart materials featuring piezoelectric elements.

UNIT- II CERAMIC AND COMPOSITE MATERIALS

Advanced Ceramic Materials - Crystal Structures – Silicate Ceramics – Glasses – Glass ceramics – Functional properties and applications of ceramic materials – Classification of composites – Fiber reinforced materials – Law of mixtures – Continuous fibers – discontinuous fibers – Application of composites in electrical and mechanical components and in nuclear industry.

UNIT- III OPTICAL MATERIALS

Modern imaging materials, Principle of imaging – Superconducting, piezoelectric, acousto – optic and electro – optic materials – Optical storage materials – Photochromic, thermoplastic and Photoresist materials – Materials suitable for detecting toxic gases.

UNIT- IV NEW MATERIALS

Smart materials – Shape memory alloys – Shape memory effect – Martensitic transformation – shape memory alloys – functional properties – processing – texture and its nature – application.

UNIT- V POLYMER MATERIALS

Classification of polymer – Mechanism of polymerisation – Some commercially important individual polymer – Thermoplastics – Elastomers – Thermosets – Engineering plastics – Liquid crystal polymers -– Conductive polymers – High performance fibers – Biomedical applications – Photonic polymers.

Books for References

1. William D. Callister, Jr., Materials Science and Engineering an Introduction, 2/em Edition, John Wiley & Sons, Inc., 2007.

2. M.V. Gandhi and B.S. Thompson, Smart materials and structures, chapman and Hall, London, First Edition, 1992.

3. K. Barriham, D.D. Vvedensky, Low dimensional semiconductor structures: fundamental and device applications, Cambridge University Press, 2001.

Ph.D COURSE WORK

19PHCW02 - MATERIAL SCIENCE

UNIT- I BULK SYNTHESIS

Top down and bottom up approaches – Mechanical alloying and mechanical ball milling – Mechano chemical process, Inert gas condensation technique – Arc plasma and laser ablation.

UNIT- II CHEMICAL APPROACHES

Sol gel processing – Solvothermal, hydrothermal, precipitation, Spray pyrolysis, Electrospraying and spin coating routes, Self-assembly, self-assembled monolayers (SAMs). Langmuir – Blodgett (LB) films, micro emulsion polymerization – templated synthesis, pulsed electrochemical deposition.

UNIT- III PHYSICAL APPROACHES

Vapor deposition and different types of epitaxial growth techniques (CVD, MOCVD, MBE, ALD) – pulsed laser deposition, Magnetron sputtering – lithography: Photo/ UV/ EB/ FIB techniques, Dip pen nanolithography, Etching process: Dry and Wet etching, micro contact printing.

UNIT- IV NANOPOROUS MATERIALS

Zeolites, mesoporous materials, nanomembranes – Carbon nanotubes and graphene – Core shell and hybrid nanocomposites.

UNIT- V APPLICATION OF NANOMATERIALS

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots – Biological Applications.

Books for References

1. S.P. Gaponenko, Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.

2. W. Gaddand, D. Brenner, S. Lysherski and G.J. Infrate (Eds.), Handbook of NanoScience, Engg. Technology, CRC Press, 2002.

3. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Imperial College Press, 2004.