DISCIPLINE-SPECIFIC ELECTIVE COURSE - 15 (DSE-15)

Advanced Coordination Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Coursetitle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Advanced Coordination Chemistry (DSE-15)	04	02	--	02	__	--

Learning Objectives:

- To introduce the basic concepts of coordination polymers and porous and cavity containing structures.
- To gather a good understanding of the chemistry, principles, design and synthesis of coordination polymers like metal-organic frameworks, coordination clustersalong with exploring their structures, properties and applications.

Learning Outcomes:

On completion of the course, the students will be able to:

- Have a strong foundation in understanding the basic concepts and properties of coordination polymers and porous and cavity containing systems.
- Gain an understanding of the different types of structures (single metal-noded, metal cluster-noded, pillared layer nets) of coordination polymers.
- Acquire knowledge on synthesis methods and how reaction conditions in synthesis can be used to design targeted coordination polymers.
- Acquire knowledge on the different types of structures of coordination polymers, e.g. MOFs, coordination clusters, etc and applications in catalysis and hydrogen storage.
- Learn about the design and morphology of self-assembling coordination compounds using suitable examples.

SYLLABUS OF DSE 15

Unit 1: (7 Hours)

Coordination polymers, assembly, single metal-noded nets, metal cluster-noded nets, pillared layer nets, and structural modulation by reaction conditions, including in situ metal/ligand reactions.

Unit 2: (7 Hours)

Coordination Polymers: Metal-Organic Frameworks and Other Terminology , 0D Coordination Clusters , 1D, 2D and 3D Structures

Unit 3: (8 Hours)

Magnetism , Negative Thermal Expansion , Interpenetrated Structures , Porous and Cavity-Containing Structures, Catalysis by MOFs , Hydrogen Storage by MOFs

Unit 4: (8 Hours)

Self-Assembling Coordination Compounds: Design and Notation, Supramolecular Cube, Molecular Squares and Boxes, Self-Assembly of Metal Arrays

Keywords:
Coordination polymers, metal-organic frameworks, self-assembly, catalysis, hydrogen storage

Practical Component:

1. Preparation of zeolite A and removal of Mg and Ca ions from water samples quantitatively using prepared zeolite A.
2. Estimation of MnO_2 in pyrolusite.
3. Preparation and characterization of following the following complexes/organometallic compound including their structural elucidation by the available physical methods. (Element analysis, molecular weight determination, conductance and magnetic measurement and special studies):
    - Synthesizing a nickel-citric acid coordination polymer using nickel nitrate, citric acid, and dimethylformamide (DMF) under solvothermal conditions.
    - Synthesizing Cu(II) coordination Polymers with 4,4-bipyridine.
    - Synthesis of *cis* and *trans* isomers of bis(glycinato) copper(II) monohydratye.
    - Synthesis of Cu acetate complex
4. Solid State synthesis-
    - Preparation of oxides and mixed oxides (Mn_2O_3, NiO, Cu_2O, Fe_3O_4, $ZnFe_2O_4$, $ZnMn_2O_4$, $CuMn_2O_4$ and $NiFe_2O_4$).
    - Preparation of Silica and Alumina by sol-Gel technique.
5. To study the electrical conductivity of ferrites, Magnetites, doped oxides and pure samples and determine band gap.

Recommended References and Textbooks

1. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall.
2. Inorganic Experiments, J. DerckWoollins, VCH.
3. Practical Inorganic Chemistry, G. Marrand, B. W. Rockett, Van Nostrand.
4. A Text Book of Quantitative Inorganic Analysis, A. I.Vogel, Longoman.
5. EDTA Titrations. F. Laschka
6. Instrumental Methods of Analysis, Willard, Merit and Dean (CBS, Delhi).
7. Inorganic Synthesis, Jolly
8. Instrumental Methods of Chemical Analysis, YelriLalikov
9. Fundamental of Analytical Chemistry, Skoog D.A. and West D.M Holt Rinehart and Winston Inc.
10. Experimental Inorganic Chemistry, W. G. Palmer, Cambridge.
11. Solid state Chemistry, N. B. Hanney
12. Introduction to Thermal Analysis, Techniques and Applications, M.E.Brown, Springer
13. Preparation and Properties of solid state Materials, Wilcox, Vol.IandII, Dekker
14. The Structure and Properties of Materials Vol.IV, JohnWulff, Wiley Eastern.

References:

1. S.R. Batten, S.M. Neville, D.R. Turner, Coordination Polymers: Design, Analysis and Application, the Royal Society of Chemistry, Cambridge, UK, 2009.

a. A.F. Wells, Three-Dimensional Nets and Polyhedra, Wiley-Interscience, New York, 1977.

b. A.F. Wells, Further Studies of Three-dimensional Nets, ACA Monograph No.8, American Crystallographic Association, Knoxville, TN, 1979.

c. A. F. Wells, Structural Inorganic Chemistry, fifteenth ed., Oxford University Press, Oxford, 1984.

2. J. Weitkamp, L. Puppe, Catalysis and Zeolites: Fundamentals and Applications, Springer, 1999.
3. D.W. Breck, Zeolite Molecular Sieves: Structure, Chemistry, and Use, Wiley, New York, 1973.
4. J.W. Steed, J. L. Atwood, Supramolecular Chemistry Chapters 9 and 10. pp. 561-583 and 620-637, John Wiley & Sons Ltd, Second Edition (2e, 2009) ISBN: 9781119582519
5. R.M. Barrer, Hydrothermal Chemistry of Zeolites, Academic Press, London, 1982.
6. J. Cejka, H. van Bekkum, A. Corma, et al., Introduction to Zeolite Molecular Sieves third ed. (Studies in Surface Science and Catalysis, Vol. 168), Elsevier, 2007.
7. S.M. Auerbach, K.A. Carrado, P.K. Dutta, Handbook of Zeolite Science and Technology, CRC, 2003.
8. C.J. Brinker, G.W. Scherer, Sol-Gel Science, Academic Press, New York, 1990.
9. R. Szostak, Molecular Sieves: Principles of Synthesis and Identification, Blackie Academic & Professional, London, 1998.