Advance Ceramics for Strategic Applications

Swayam Prabha Course Code: M70

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COURSE OUTLINE	"Advanced Ceramics" constitute a group of materials other than the clay minerals based "traditional ceramics" and are one of the fastest growing groups of materials particularly for advanced technology applications replacing, in many cases, conventional metals and alloys. While "traditional ceramics" are based primarily on naturally occurring raw materials, the "advanced ceramics" use mostly synthetic or specially prepared raw materials. Therefore, preparation of synthetic raw material constitutes an important part of this course. Consolidation of the powdery raw materials into desirable and in many cases complex shapes requires understanding the basic principles of different techniques of ceramic processing and fabrication. Advanced ceramic materials are used not only in the bulk shapes but also in the form of thick or thin films as well as in single crystals. In addition, ceramics are also used in the fiber form. From the chemistry point of view the materials cover a very wide spectrum of compounds e.g. oxides, carbides, nitrides, oxy-nitrides, silicides as well as their combinations. Their properties and consequently the area of applications vary quite significantly. Many new and exotic properties are possible to be developed in these materials and therefore, one can think of several exotic applications. Advanced ceramics are known for their unusual electrical, magnetic, mechanical, optical and eletrooptic properties. Their importance lies in their extra-ordinary strength at high temperatures, much better abrasion and tribological properties, insulating, semi-conducting, conducting and even superconducting properties, dielectric and piezoelectric properties, soft and hard magnetic properties. Besides one can make ionically conducting ceramics for electrochemical applications. Ceramics can be fabricated with controlled pores size and porosity particularly for different types of separation technologies. It is also possible to develop either bio-inert or bio-active ceramics for use as bio-medical implants. Advanced ceramic products are commonly used in a variety of engineering industries, microelectronics, thermal engineering, sensor and actuator technology, environmental engineering, energy

	technology, water purification technology, biomedical engineering etc. covering different sectors like atomic energy, defence, space and civilian applications. Exotic ceramics such as functionally graded, smart/ Intelligent, bio-mimetic and nano-ceramics are also becoming important for different applications. All these aspects will be covered in details.

COURSE DETAILS

S. No	Module ID/ Lecture ID	Lecture Title/Topic
1.	Module1_L1	Introduction
2.	Module1_L2	Introduction (Contd.) - I
3.	Module2_L3	Crystal Structure
4.	Module2_L4	Crystal Structure (Contd.) – I
5.	Module2_L5	Crystal Structure (Contd.) – II
6.	Module2_L6	Crystal Structure (Contd.) - III
7.	Module3_L7	Defects in crystalline solids
8.	Module3_L8	Defects in crystalline solids (Contd.) - I
9.	Module4_L9	Dislocation
10.	Module5_L10	Two and Three Dimensional Defects
11.	Module6_L11	Electrical Conduction in Ceramics
12.	Module6_L12	Electrical Conduction in Ceramics (Contd.) - I
13.	Module6_L13	Electrical Conduction in Ceramics (Contd.) - II
14.	Module6_L14	Electrical Conduction in Ceramics (Contd.) - III
15.	Module6_L15	Electrical Conduction in Ceramics (Contd .) - IV
16.	Module6_L16	Electrical Conduction in Ceramics (Contd .) - V
17.	Module7_L17	Electrical Phenomenon in Insulators
18.	Module7_L18	Electrical Phenomenon in Insulators (Contd.) - I
19.	Module8_L19	Ferroelectric , Piezoelectric and Pyroelectric

		Ceramics
20.	**Module8_L20**	Ferroelectric , Piezoelectric and Pyroelectric Ceramics (Contd.) - I
21.	**Module8_L21**	Ferroelectric , Piezoelectric and Pyroelectric Ceramics (Contd.) – II
22.	**Module8_L22**	Ferroelectric , Piezoelectric and Pyroelectric Ceramics (Contd.) - III
23.	**Module9_L23**	Relaxor Ferroelectrics
24.	**Module10_L24**	Superconductivity
25.	**Module10_L25**	Superconductivity (Contd.) - I
26.	**Module11_L26**	Ceramic Gas Sensor
27.	**Module11_L27**	Ceramic Gas Sensor (Contd.) - I
28.	**Module12_L28**	Solid Oxide Fuel Cell
29.	**Module12_L29**	Solid Oxide Fuel Cell (Contd.) - I
30.	**Module12_L30**	Solid Oxide Fuel Cell (Contd.) - II
31.	**Module13_L31**	Hydrogen Generation through MIEC Reactor
32.	**Module14_L32**	Lithiuum Ion Battery
33.	**Module14_L33**	Lithiuum Ion Battery (Contd.) - I
34.	**Module15_L34**	Magnetic Ceramics
35.	**Module15_L35**	Magnetic Ceramics (Contd.) - I
36.	**Module15_L36**	Magnetic Ceramics (Contd.) - II
37.	**Module15_L37**	Magnetic Ceramics (Contd.) - III
38.	**Module16_L38**	Sintering of Ceramics
39.	**Module16_L39**	Sintering of Ceramics (Contd.) - I
40.	**Module16_L40**	Sintering of Ceramics (Contd.) - II
41.	**Module16_L41**	Sintering of Ceramics (Contd .) - III
42.	**Module17_L42**	Mechanical Properties of Ceramic Materials
43.	**Module17_L43**	Mechanical Properties of Ceramic Materials (Contd.) -I
44.	**Module17_L44**	Mechanical Properties of Ceramic Materials (Contd.) -II

45.	**Module17_L45**	Mechanical Properties of Ceramic Materials (Contd.) -III
46.	**Module18_L46**	Structural Ceramics Materials
47.	**Module19_L47**	Bioceramics

List of reference material/ books:

1. Fundamental of Ceramics by Michel W. Barsoum, McGraw Hill International edition, 1997

2. Modern Ceramic Engineering by David. W. Richerson, Mercel Dekker, NY 1992

3. Ceramic Processing and Sintering by M. N. Rahman, Mercel Dekker, 2003

4. Handbook of Advanced Ceramics by S. Somiya, Academic Press 2003

5. Handbook of Advanced Ceramics, Parts 1 and 2, S. Somiya, Aacdemic Press, 2006

Name and contact details of two referees for the course: