MATLS 3B03 course outline

Materials Production

Term 2, 2017/2018

Instructor: Dr. I Zhitomirsky (zhitom@mcmaster.ca, JHE A418)

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Description:
Technology and surface science related to the preparation of fine particles of minerals, metals and ceramics for industrial production.
Applications of electrochemistry for diverse materials processing, such as electrometallurgy, thin film production and anodizing.

DETAILED COURSE CONTENTS

1. Mass balance, practical examples of mass balance calculations
2. Examples of advanced materials and their applications
3. Ideal powder characteristics for synthesis and sintering
4. Solid state synthesis method (concept and examples of chemical reactions and applications)
5. Design of advanced materials using solid solutions (concept, examples of practical applications)
6. Fabrication of hydroxide and oxide materials by wet chemical methods using inorganic salts (concept and examples of chemical reactions for individual hydroxides and oxides)
7. Fabrication of complex hydroxide and oxide materials by wet chemical methods: importance of pH control (concept and examples), importance of precursors (concept and examples)
8. Homogeneous nucleation, energy balance for nucleation
9. Ostwald Ripening (concept, mechanism)
10. Citrate gel method, glycine nitrate method, Pechini method, hydrothermal method (concept, advantages, examples of applications)
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11. Spray drying, freeze drying, spray pyrolysis methods (concepts and practical applications)
12. Charge of oxide particles as a function of pH, related surface reactions, isoelectric point
13. Colloidal solutions, xerogel, aerogel
14. Sol-gel method, hydrolysis and condensation reactions (examples of reactions)
15. Effect of water/alkoxide ratio and pH on hydrolysis
16. Technological problems related to the fabrication of oxide films by sol-gel methods and their practical solutions
17. Powder metallurgy. Production of Ni by decomposition of carbonyl, production of SiC and Si$_3$N$_4$ (examples of reactions)
20. Nernst diffusion layer, galvanostatic and pulse deposition, advantages of pulse deposition, leveling mechanism, electrodeposition of Zn and Ni, corrosion protection mechanism of Zn coatings.
21. Electroless and displacement deposition mechanisms
22. Advantages and disadvantages (limitations) of electrodeposition and electroless deposition methods
23. Electrodeposition of alloys, deposition of multilayer alloys, applications of multilayer alloys
24. Properties and application of conductive polymers, chemical polymerization, electropolymerization of films on various substrates
25. Electrode reactions in aqueous solutions, cathodic and anodic deposition of polymers, deposition mechanisms
26. Polyelectrolytes: weak and strong
27. Electrolytic deposition of hydroxides and oxides (electrosynthesis): cathodic and anodic methods
28. Electrophoretic deposition mechanism
29. Comparison of electrophoretic and electrolytic deposition
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30. Hydrometallurgy. Flotation mechanism. Direct and reverse flotation, flotation additives: collectors, function of different modifiers


33. Structure of surfactant molecules, different types of surfactants

34. DLVO theory, concept of zeta potential

35. Tape casting, slip casting, extrusion, function of different additives

36. Binders, advantages of co-polymer binders

37. Stabilization of particles in aqueous and non-aqueous suspensions


40. Particle characterization. Methods of analysis of open and closed porosity.

41. Analysis of particle size and surface area. BET method.

Textbooks


Additional literature

W.G. Davenport et al. Extractive Metallurgy of Copper, 4th Edn, Pergamon 2002


Course operating information
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3 lectures per week, Mon, Wed 11.30-12.20, Fri 13.30-14.20 BSB 117

Class test 1 February 5, 11.30-12.20, BSB 117, Class test 2 March 5, 11.30-12.20, BSB 117

Assignment deadlines: Assignment 1 February 26, Assignment 2 March 26

ASSESSMENT:

1. Two class tests 30%
2. Assignments 20%
3. Final exam 50%
Total 100%

POLICY REMINDERS:

Senate and the Faculty of Engineering require all course outlines to include the following reminders: The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem, that cannot be resolved by discussion among the persons involved, individual are reminded that they should contact the Department Chair, the Sexual Harassment Office or the Human Rights Consultant, as soon as possible. Students should be reminded that they should read and comply with the "Statement on Academic Ethics and the Senate Resolution on Academic Dishonesty" as found in the Senate Policy Statements distributed at registration and available in the Senate Office.

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