

MECH 4395 – Synthesis and Processing of Materials

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Course Description:	An overview of chemical reactivity are discussed with first interpreting the fundamentals of reactionary thermodynamics, heterogenous kinetics, and phase equilibria. Then the fundamental concepts are applied in specialized topics such as chemical synthesis/processing of advanced materials (intermetallics, ceramics and composites).
Textbook:	The course will introduce several topics covered in numerous monographs and journal publications, which will be noted in class.
References:	Y. K. Rao: Stoichiometry and Thermodynamics of Metallurgical Processes, Cambridge University Press, 1985. O. Levenspiel: Chemical Reaction Engineering, Wiley, 1999. J. Maier: Physical Chemistry of Ionic Materials, Wiley, 2004 Y. A. Chang and W. A. Oates: Materials Thermodynamics, Wiley, 2010.
Topics Covered:	1. Chemical synthesis and processing of materials (e.g., intermetallics and metastable phases) 2. Liquid phase reactions with structural ceramics and composites 3. Synthesis of materials with surface related techniques 4. Metal/Ceramic Reactions 5. Plasma processing of materials
Assessment of Course:	1. Mid-term examination (40% of final grade) 2. Fundamental engineering report will amount to 60% of final grade. An electronic version, pdf, of an outline for report is due on March 18 and a full-draft report due on April 18. The report may be revised as per instructor comments and submitted by May 6 to improve final grade.

Organization of Topics

Fundamental Concepts	Topics	Applications
Reactionary Thermodynamics	Fluid/Solid Reactions	Energy Related
-- Fluid/Solid Reactions	-- Liquid Metal/Ceramic	-- Coal Conversion
-- Solution Thermodynamics	-- Extreme Environments	-- Chemical/Oil Industries
	-- Liquid Oxides/Refractory	-- Fuel Cell Usage
Heterogeneous Kinetics	Solid/Solid Reaction	Electronic Materials
-- Analysis of Rate Equations	-- Metal/Ceramic Reactions	-- Sensors
-- Reaction Sequence	-- Phase Stability	-- Electroceramics
Transport Phenomena	-- Intermetallic Phases	-- Silicon systems
-- Fluid/Condensed Phases	Liquid/Condensed Phases	Ceramic Systems
-- Gradients of Velocity and Temperature	-- Mass Transfer	-- Solid Electrolytes
	-- Energy Transfer	-- Ceramic Composites
Phase Equilibria		Transport Related Industries
-- Phase Diagrams		-- Turbine Materials
-- Microstructures		-- Hypersonic Vehicles
