Form 2B

City University of Hong Kong

Information on a Course
offered by Department of Mechanical and Biomedical Engineering
with effect from Semester B 2012/2013

Part I

Course Title: **Kinetics in Nanoscale Materials**

Course Code: **MBE6107**

Course Duration: **One Semester**

Credit Units: **3**

Level: **P6**

Medium of Instruction: **English**

Prerequisites: **Background knowledge in related disciplines is required and course registration will be subject to the approval of the Course Examiner**

Precursors: **Nil**

Equivalent Courses: **MBE8102**

Exclusive Courses: **Nil**

Note:

Students may repeat a course, or an equivalent course, to improve course grade only if the previous course grade obtained is C or below.

Part II

1. Course Aims

The aim of this course is to explain why the subject of kinetics in nanoscale materials is of wide interest today; because of its link to nanotechnology. In recent years, a major development in science and engineering is nanoscience and nanotechnology. At the moment, the research and development on nanoscale materials science for nanotechnology is ubiquitous. For example, the study of silicon, metal, and oxide nanowires. To build the nanowire device hetero-structure of silicide/Si/silicide requires the study of line contact reaction between Si and metal nanowires to form the silicide electrodes. To use Ag nanowire mesh as the transparent conducting electrodes on flexible solar cells requires the study of point contact reaction between two Ag nanowires. What is unique in kinetics in nanoscale materials is the dominant effect of Gibbs-Thomson potential energy, high concentration gradient, large quantity of non-equilibrium vacancies, very few dislocations, yet very high density of nanotwins and grain boundaries. These parameters will be addressed in this course. This course will be given mainly by Prof. King-Ning Tu, a world expert in kinetics of nanomaterials, from University of California at Los Angeles, USA.

2. Course Intended Learning Outcomes (CILOs)

Upon successful completion of this course, students should be able to:

No.	CILOs	Weighting* (if applicable)
1.	Learn the unique microstructure and kinetic behaviors of nanoscale materials such as nanospheres, nanowires, nanothickness thin films, and nanostructure in bulk-type materials.	3
2.	Understand linear and non-linear diffusion equations and solutions for nano materials.	3
3.	Analyse Kirkendal effect and inverse Kirkendall effect and their interaction in core-shell nanoscale materials.	2
4.	Learn spinodal decomposition and chemical potential in inhomogenous solid solution and interdiffusion in man-made superlattices.	3
5.	Identify and apply ripening kinetics among nano-precipitate and the mean-field assumption in LSW theory of ripening	3
6.	Analyse and design thermodynamics and kinetics of homogeneous nucleation. Homogenous nucleation is rare in bulk materials and that is why F. C. Frank's model of spiral growth around a screw dislocation was invented to overcome homogeneous nucleation. The link between Zeldowitch's steady state nucleation theory and experimental study of repeating homogeneous nucleation of epitaxial silicide in Si nanowires will be derived and applied to both functional materials.	3

*Weighting ranging from 1, 2, 3 to indicate the level of importance in an ascending order.

3. Teaching and Learning Activities (TLAs)

(Indicative of likely activities and tasks designed to facilitate students' achievement of the CILOs. Final details will be provided to students in their first week of attendance in this course)

Activity Type:	Timetabled Activity (Hours per week)
Lecture	Lecture (3)

CILO No.	Large Class Activities (Lecture)	Total Hours
CILO 1	8	8
CILO 2	8	8
CILO 3	4	4
CILO4	7	7
CILO 5	6	6
CILO 6	6	6
Total	**39**	**39**

4. Assessment Tasks/Activities

(Indicative of likely activities and tasks designed to assess how well the students achieve the CILOs. Final details will be provided to students in their first week of attendance in this course)

	Coursework		
CILO No.	**Quiz**	**Assessment of Term Report**	**Total (%)**
CILO 1	-	-	-
CILO 2	-	-	-
CILO 3	-	-	-
CILO 4	30	-	30
CILO 5	-	-	
CILO 6	-	20	20
CILO 1,2,3,5,6	50	-	-
Total (%)	**80**	**20**	**100**

5. Grading of Student Achievement:

Letter Grade	Grade Point	Grade Definitions
A+	4.3	Excellent
A	4.0	
A-	3.7	
B+	3.3	Good
B	3.0	
B-	2.7	
C+	2.3	Adequate
C	2.0	
C-	1.7	
D	1.0	Marginal
F	0.0	Failure
P	-	Pass

Please refer the SGS's website:
http://www.sgs.cityu.edu.hk/student/tpg/assessment/coursegrades#01 for more details.

Part III

Keyword Syllabus:

Past, present, and future microelectronic technology, Overview of kinetic processes in nanoscale materials, Linear and non-linear diffusion, Kirkendall effect and inverse Kirkendall effect,

Ripening, Spinodal decomposition, Nucleation events in bulk, thin film, and nanoscale materials, and Growth events in contact reactions on Si; plane, line, and point contacts.

Recommended Reading:

There is no textbook on this subject, but lecture notes of all the lectures are available and will distributed to all the students in the class.
The following books on kinetics in phase transformations are helpful.

(1) D. A. Porter and K. E. Easterling “Phase transformation in metals and alloys,” Chapman & Hall, London (1992).
(2) Paul Shewmon, 2nd edition on “Diffusion in solids,” TMS, Warrendale, Pa. (1989).
(3) King-Ning Tu, “Kinetics in Nanoscale Materials,” Wiley and Son, to be published in 2013.