100 學年第 1 學期 電子薄膜科技

Electronic thin film Technology 課程綱要

課程名稱：（中文）電子薄膜科技 （英文）Electronic thin film Technology			開課單位		工科系
			科號 Course Number		
任課教師: 歐陽汎怡					
學分	3	必/選修	選修	開課年級	研究所課程
先修科目或先備能力： 建議先修習薄膜工程導論 (Introduction to Thin Film Engineering)					
課程說明(Course Description)： It is well known that thin films are widely used in the electronic industry. Due to the trend on miniaturization of electronic devices, nanosclae electronic devices are needed and the technology and reliability of thin films have recently attracted increasing attentions. This course will focuses on the science and process of thin films, and reliability science for thin film application in the electronic industry. The topics will cover: 1. Fundamental topic in thin-film process: deposition, surface energy and atomic diffusion 2. Application of diffusion equations (Fick's first law and Fick's second law) 3. Theoretical and practical understanding of electronic thin-film reliability: electromigration, thermomigration and stress-migration					
指定用書(Text Books)	"Electronic Thin-Film Reliability", King-Ning Tu, Cambridge University Press, 2010, ISBN 978-0-521-51613-6.				
參考書籍(References)	1. "Thin film deposition" Donald L. Smith, MC Graw Hill, 1999. 2. "Electronic thin film Science for electrical engineers and materials scientists" King-Ning Tu, James W. Mayer, and Leonard C. Feldman, MACMILLAN, 1992. 3. "Microelectronics packaging handbook" R.R. Tummala and E.J. Rymaszewski, Van Nostrand Reinhold, 1989 4. "微電子材料與製程，陳力俊主編中國材料科學學會 2000				

教學要點概述：

1. 教學方式(Teaching Method): 投影片(上網)教學及隨堂筆記

2. 成績考核(Evaluation) :
   (1) 學期作業 Homework :15%

   (2) Midterm 30%

   (3) Final exam:30%

   (4) Presentation :25%

3.教學進度表

週次	內容
1	**Introduction : Thin Film Applications to Microelectronic Technology**
2	**Thin Film Deposition** ✓ Flux equation of thin film deposition/ thin film deposition rate ✓ Kinetic energy of gas molecules/ frequency of collision of gas molecules ✓ Bolzmann's velocity distribution function and ideal gas law

	✓ Maxwell's velocity distribution function and kinetic energy of gas molecules
3	**Surface Energy in Thin Films** ✓ Surface energy and surface tension ✓ Liquid surface energy measured by capillary effect ✓ Solid surface energy measured by zero creep ✓ Magnitude of surface energies
4	**Surface Kinetic Processes on Thin Films** ✓ Surface diffusion ✓ Step mediated growth in homoepitaxy ✓ Homogeneous nucleation of a surface disc ✓ Mass transport on patterned surfaces ✓ Ripening of a hemispherical particle on a surface
5	**Atomic Diffusion in Crystalline Solids /Application of diffusion equation** ✓ Fick's first law and applications of Fick's first law (Zener's and Kidson's analysis) ✓ Fick's second law applications of Fick's secondt law (Darken's analysis/ Boltzmann and Matano's analysis/ Kirkendall void formation) ✓ Diffusion coefficient (parameters in diffusion coefficient/ calculation of diffusion coefficient)
6	**Applications of Diffusion Equation/ Grain Boundary Diffusion** ✓ Analysis of growth of a solid precipitate (Ham's model) ✓ Fisher∗s analysis of grain boundary diffusion ✓ Whipple∗s analysis of grain boundary diffusion
7	**Elastic Stress and Strain in Thin Films** ✓ Biaxial stress in thin films ✓ The origin of intrinsic stress in thin films ✓ Stoney∗s equation of biaxial stress in thin films ✓ Measurement of thermal stress in Al thin films ✓ Application of Stoney∗s equation to thermal expansion measurement
8	**Interdiffusion and Reaction in Thin Films** ✓ Silicide formation ✓ Kinetics of interfacial-reaction-controlled growth in thin film reactions ✓ Marker analysis in intermetallic compound formation
9	**Midterm**
10	**Reliability: Electromigration in Metals** ✓ Concept and physical mechanism for electromigration ✓ The effect of back stress in electromigration and how to measurement it ✓ Current crowding effect and current density gradient force of electromigration
11	**Reliability: Electromigration induced failure in Al and Cu Interconnects** ✓ Electromigration induced failure due to atomic flux divergence ✓ Electromigration induced failure due to electric current crowding ✓ Void formation in the low current density region ✓ Electromigration induced failure in Al interconnects and Cu interconnects (microstructure, Mean time to failure etc)
12	**Reliability: Thermomigration:** ✓ Concept and physical mechanism for thermomigration ✓ Thermomigration in flip chip solder joints of SnPb ✓ Thermomigration in flip chip solder joints of Pb-fee
13	**Company Visiting- TSMC-tentative**
14	**Reliability: Stress Migration in Thin Films** ✓ Concept of chemical potential in a stress solid and diffusion creep ✓ Void growth in Al interconnect driven by tensile stress ✓ Whisker growth in Sn/Cu thin films driven by compressive stress
15	**Reliability: Irreversible Processes in Interconnect and Packaging Technology** ✓ Entropy production due to heat conduction/ atomic diffusion/ electrical condition ✓ Irreversible process in electromigration/ thermomigration
16	**Reliability Science and analysis** ✓ Effect of lattice shift on divergence of mass flux in irreversible process

	✓ Physical analysis of electromigration failure in flip chip solder joints ✓ Statistical analysis of electromigration in flip chip solder joints
17	**Group presentation** ✓ Students will need to give a presentation related to thin film application in the industry.
18	**Final Exam**