明志科技大學課程綱要表

課程名稱：（中文）電池材料結晶技術 （英文）Crystallization Technology of Battery Materials				開課單位	能源電池科技博士班
				課程代碼	
授課教師： 簡文鎮					
學分數	3	必/選修	選修	開課年級	
先修科目或先備能力：質能平衡、物理化學、反應工程、化工熱力學、基礎英文閱讀					
課程概述與目標：本課程主要在講授結晶相關的理論、設備及應用，內容分 8 個單元，分別為：各種物質與晶體結構及狀態介紹、晶體的物理及化學與熱性質、溶液與溶解度、相平衡、成核機制、晶體成長、結晶操作的技術與設備、結晶槽的操作與設計。同學修過此課程後，可提升其在結晶的相關理論、設備及應用方面的瞭解，也會對結晶在產業之實際應用有深一層的認識，故對其專業及就業能力的提升均有很大的助益。本課程使用英文教材，可增進學生英文閱讀能力，對研究生可協助其提昇論文的品質。另外本課程在各單元的授課中均會提出一些目前結晶技術之發展狀況與實際之問題與學生討論，在討論中培養學生有獨立思考問題的能力及掌握國際產業及科技方向的能力，為終身學習打下好的基礎。					
教科書 [1]	1.J. W. Mullin, ***Crystallization***, 4th ed., Butterworth-Heinemann, 2001.				

課程綱要		核心能力達成指標	對應之學生核心能力
單元主題	內容綱要		
The crystalline state	物質結晶現象及晶體各種相關性質的介紹。	1,2,3,4,6,7	1.瞭解物質結晶現象與各種相關性質。2.能閱讀相關之論文或技術報告。3.能分辨結晶與非結晶物質之差異。4.能瞭解晶體在生活中的各種應用。
Physical and thermal properties	物質結晶現象與其物理性質或熱性質之探討。	1,2,3,4,6,7	1.瞭解結晶物質之各種相關性質。2.能閱讀相關之論文或技術報告。3.能探討晶體結構與性質之特性。4.能瞭解物質結晶現象與其性質在材料研發中的各種應用。
Solutions and solubility	溶液性質與結晶現象的關係及溶解度之計算。	1,2,3,4,6,7	1.瞭解溶液與結晶操作之相關性。2.能計算溶液的溶解度與過飽和度。3.能閱讀相關之論文或技術報告。4.能探討晶體結構與性質之特性。
Phase equilibrium	相平衡與結晶現象之探討。	1,2,3,4,6,7	1.瞭解相平衡與結晶現象之相關性與應用。2.能計算結晶的操作條件與理論產量。3.能閱讀相關之論文或技術報告。
Nucleation	初成核、次成核現象之理論、機制及實際物系及應用之探討及計算。	1,2,3,4,6,7	1.瞭解結晶成核之現象與各種理論。2.能閱讀相關之論文或技術報告。3.能計算不同物系之成核速率。4.能將成核控制應用於晶體品質之控制。5. 能瞭解成核的最新理論與技術發展。
Crystal growth	晶體成長現象之理論、機制及實際物系與應用之探討及計算。	1,2,3,4,6,7	1.瞭解結晶成長之現象與各種理論。2.能閱讀相關之論文或技術報告。3.能計算不同物系之晶體成長速率。4.能將成長控制應用於晶體品質之控制。5.能瞭解成長的最新理論與技術發展。

Crystallization techniques and equipment	結晶技術及其應用及相關設備如攪拌槽式、流化床式、混合式、強制循環式結晶槽之介紹。	1,2,3,4,5,6,7	1.瞭解各種的結晶技術與應用。2.能瞭解各種的結晶設備與應用。3.能閱讀相關之論文或技術報告。4.能瞭解結晶技術與設備的最新理論與技術發展。5.能了解結晶工程對環境與安全之責任。
Crystallizer operation and design	結晶槽之選擇、操作及結晶槽設計之各項參數的計算	1,2,3,4,5,6,7	1.瞭解各種的結晶反應器的選擇基準與操作技巧。2.能計算結晶槽中各種的操作條件。3.能閱讀相關之論文或技術報告。4.能瞭解結晶槽的最新理論與技術發展。5.能了解結晶槽設計對環境與安全之責任。
教學要點概述[2]： 參考教材：O. Sohnel and J. Garside, ***Precipitation***, Butterworth-Heinemann, 1992。 教學方法：本課程教學以課堂理論講授為主，學生報告相互討論為輔。 評量方法：平時成績30%、口頭報告30%、期末考40%。 教學相關配合事項： 可透過網路大學學習平台取得課程輔助教材及授課相關資料。			

註：1. 教科書請註明書名、作者、出版社、出版年等資訊。

2. 教學要點概述請填寫教材編選、教學方法、評量方法、教學資源、教學相關配合事項等。

3. 學程所有開設之課程皆須填寫此表格或提供原有格式之課程綱要表，呈現於實地訪評現場。

COURSE SYLLABUS

Course Title：
Crystallization Technology of Battery Materials

Credits / Hours	3/3	**Course Number**		☐**Required** ■**Elective**

Brief Course Description& Curriculum Objective:

The object of this course is to describe the important aspects of crystallization theory and practice, together with some closely allied topics. For improving the students' English ability, this course uses English textbook and uses some studies or reports published in the literature about the crystallization technology as the teaching materials. This course includes many most important topics for crystallization technology such as the crystalline state, physical and chemical properties, solutions and solubility, phase equilibria, nucleation, crystal growth, crystallization techniques and equipment, and crystallizer operation and design. The content of this course will not only help students to understand the theory and principles of crystallization and crystallizer design, but also let students in the future can apply these knowledge in the industrial separation. In addition, the curriculum taught in each topic will include the current state of development for crystallization technique, which can train students the ability to think independently and to keep the ability for lifelong learning.

Course Topics

Topic	Content
The crystallization state	This topic describes many issues of crystallization state, including liquid crystals, crystalline solids, crystal systems, miller indices, space lattices, isomorphs and polymorphs, enantiomorphs and racemates, crystal habit, dendrites, composite crystals and twins, and imperfections in crystals.
Physical and thermal properties	This topic introduces many important material properties for crystallization, including density, viscosity, surface tension, diffusivity, refractive index, electrolytic conductivity, crystal hardness, units of heat, heat capacity, thermal conductivity, boiling, freezing and melting point, latent heats of phase change, heats of solution and crystallization, and size classification of crystals.
Solutions and solubility	This topic includes the following issues such as solutions and melts, solvent selection, expression of solution composition, solubility correlations, theoretical crystal yield, particle size and solubility, effect of impurities, measurement of solubility, prediction of solubility, supersolubility, and solution structure.
Phase equilibria	This topic describes many issues for crystallization, including the phase rule, one or two-component systems, enthalpy-composition diagram, phase change detection, three or four-component systems, and dybamic phase diagrams.

Nucleation	This topic describes many issues for crystallization, including the primary nucleation, secondary nucleation, metastable zone widths, effects of impurities, induction and latent periods, interfacial tension, Oswald's rule of stages.
Crystal growth	This topic describes many issues for crystallization, including the crystal growth theories, growth rate measurements, crystallization and dissolution, crystal habit modification, phase transformations, and inclusions.
Crystallization techniques and equipment	This topic describes many issues for crystallization, including the recrystallization, precipitation, crystallization from melts, sublimation, crystallization from solution, caking of crystal.
Crystallizer operation and design	This topic describes many issues for crystallization, including the crystal size distribution, kinetic data measurement and utilization, crystallizer specification, fluid-particle suspensions, encrustation, and downstream processes.