課務系統課程大綱

課程：Polymer Synthesis and Polymer-coated Nanoparticles（高分子製程）

教師：Pei Yuin Keng（龔佩雲）

項目	此科目對應之系所課程規畫所欲培養之核心能力 Core capability to be cultivated by this course	權重（百分比） Percentage
1	運用數學、科學及材料科學與工程知識的能力 The ability to employ the knowledge of mathematics, science, and materials science & engineering.	30
2	設計及執行實驗，以及分析解釋數據的能力 The ability to design and execute experiments, analyze and interpret data.	20
3	執行實驗所需技術、技巧及使用實驗工具解決問題之能力 The ability to employ the techniques and tools that are needed in executing experiments and in solving problems.	20
4	設計工程系統或製程之能力 The ability to design engineering systems or processes.	10
5	有效溝通及團隊合作的能力 The ability to communicate and cooperate in team works.	10
6	發掘、分析及處理問題的能力 The ability to discover, analyze, and solve problems.	5
7	認識當代材料問題，瞭解材料對於環境、社會及全球的影響，並培養持續學習的習慣與能力 The ability to know contemporary materials issues, to realize the influences of materials on the environment, the society, and the globe, and to keep the habit of learning continuously.	5
8	瞭解專業倫理及社會責任 The ability to realize professional ethics and social responsibility.	

一、課程說明(Course Description)

The **Polymer Synthesis and Polymer-coated Nanoparticle** is a graduate level course focused on the fundamentals of various polymerization approaches towards commercial and new polymeric materials. The main objective of this course is to equipped students with the basic knowledge of polymer structures and properties correlation and being able to design desirable polymer ligands for a specific application. Students will be accustomed to different types of monomers and features of each polymerization methods at the end of this course. Secondly, this course will provide students with greater appreciation of nanomaterials and versatility of polymers in designing new materials with higher performance and processability. This course will be divided into 2 parts: (1) Polymer Synthesis and (2) Polymer-coated Nanoparticles, in which the knowledge of polymer

synthesis will be applied to functionalize nanoparticle for a specific application. In the first part of this course, basic polymers structures, properties, polymerization mechanism, kinetic, and main difference between each polymerization approaches will be highlighted. Specifically, new and developing living radical polymerization technique will be address and discussed in greater depth with assigned literatures. In Part 2 of this course, features of nanoparticle, size, surface area, methods of preparation and functionalization of nanoparticles with polymer ligands for biomedical application will be discussed. At the end of this course, a special topic on nanoparticles for theranostic will be presented. Upon a brief introduction on theranostic, a case study in designing nanoparticles for theranostic will be discussed, integrating lecture materials in Part 1 and 2 of this course.

二、指定用書(Text Books)

Odian, George. Principles of Polymerization. 4th ed. Hoboken, NJ: Wiley-Interscience, 2004. ISBN: 9780471274001.

Supplementary Handouts will be used frequently and will be handed out in lecture as needed during the course.

三、參考書籍(References)

1. Nagarajan, R., Hatton, T.A. Nanoparticles: Synthesis, Stabilization, Passivation and Functionalization. American Chemical Society.
2. Henry H, Hsieh and Roderic O, Quirk, Anionic Polymerization, Principles and Practical Application, Marcel Dekker, Inc.
3. Krzysztof Matyjaszewksi, Cationic Polymerization, Marcel Dekker, Inc.

四、教學方式(Teaching Method)

This course will focused on in class lecture and discussions on the topics listed in the syllabus. Asides from the assigned text books, this course will also introduce relevant literatures on the topic taught on the given week or previous week as a discussion platform. To encourage students to participate in the discussion, extra credits point will be given. More important, the literature assignment is geared towards cultivating students to read, think critically and ultimately promote creativity and guide students to apply his/her knowledge for their own research project. In terms of course work, there will be a short quiz on a biweekly basis to test the understanding of students on the lectures content of the given week. Based on these quizzes, the lectures can be slightly modified based on the average class progress. In addition to biweekly quizzes, there will be occasional homework assignments. The midterm and final exams will be based on open book and notes format in this course to evaluate students understanding and their ability to integrate the lecture materials in research settings. A case study in designing nanoparticle for theranostic will be discussed in class as a guidance platform for students to prepare for their final research presentation. The details of the research project can be found on the course website.

五、教學進度(Syllabus)

Please see the attached document

六、成績考核(Evaluation)

In this course, there will be biweekly quizzes, homework assignments, midterm exam, final exams and an independent research project. The percentage of each is outlined in the following table. The quizzes and homework assignments are mainly to keep students on track on their course materials. Both mid-terms and final exams will be open book format to test their understanding, ability to integrate and apply lecture materials in research setting. The following table showed the point breakdown for the exams, homework, quiz and research project design.

Activities	Percentages (%)
Quiz	5
Homework assignment	10
Mid-term exam	30
Final Exam	30
Research project	25
Extra credits for in-class participation	10

七、可連結之網頁位址（無）

NTHU SP18_Intro Polymer and NPs_Syllabus

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Week	Content	Important notes
1	General introduction to polymers: (a) Composition and structure (b) Mechanism (c) Nomenclature (d) Linear, branched and crosslinked polymers	Reading: Odian Ch. 1
2	(e) Structural features of polymers (f) Solution state characterization (g) Solid state characterization, morphology and mechanical properties	Literature assignment: Lodge, T.P.; Muthukumar, M. J. Phys. Chem. 1996, 100, 13275
3	Fundamental of step growth polymerization (a) Mechanism and polymerization rate, kinetics (b) Molecular weight determination and polydispersity (c) (Trans)esterification polymers (d) Hyperbranched, crosslinked, gelation	Reading: Odian Ch. 2
4	Structure-property correlation (a) Aliphatic, aromatic polyester (b) Thermoset, thermoplastic (c) High performance polymers	Literature assignment: Marvel, C.S., *J. Chem Educ*., 1981, 58(7), pp. 535.
5	Introduction to chain polymerization (a) Comparison between step growth and chain polymerization (b) Elementary reactions (initiation, propagation, termination and transfers) (c) Copolymerization	Literature assignment: Matyjaszewski, K. et al.: *Macromol*. **1999**, 32, 7031-7031
6	(d) Emulsion dispersed media polymerization (e) Controlled living polymerization (h) Atom transfer radical polymerization (i) Nitroxide mediated polymerization Reading: Odian Ch. 4.	Literature assignment: Hawker C.J.: *J. Chem Rev*, **2001,** 101, 13275. (B) Matyjasweski et al., *Acc. Chem Res*. **1998**, 21, 2124
7	Features of Anionic polymerization (a) Fundamentals of carbonic species (structure, stability, ion pairs) (b) General aspect of polymerization kinetics (c) Copolymerization and block copolymers (d) Complex architecture through coupling agents	Literature assignment: Hadichristidies et al., *Chem Rev*. **2001**, 101, 13275
8	Features of Cationic polymerization (a) Fundamentals of cationic polymerization (monomers, initiators) (b) Controlled polymerization (vinyl ethers, cyclic ethers, oxazolines)	
9	Polymer functionalization and modification	Reading: Odian Ch. 9

	(a) Introduction, motivation, yield, crystallinity, solubility, steric effects and other consideration (b) Common functionalization approaches (c) Comparison of polymer versus monomer functionalization approaches	
10	Introduction of Polymers-coated Nanoparticles (a) Features of nanoparticles (b) Bulk versus nanosized properties (c) Size dependent properties: electrochemical, magnetic, optical (d) Common examples of nanoparticles and its characteristic, method of preparation, morphology.	Review: (a) Lin Z.Q., et al., Nat. Nanotech. 2013, 8. 426-431.
11	(e) Continue: Common examples of nanoparticles and its characteristic, method of preparation, morphology Methods of characterization (TEM, AFM, SEM, Raman, DLS) (a) Basic operation, imaging principle, sample preparation	
12	Roles of polymer ligands in nanoparticle stabilization (a) Polymer ligands for inorganic nanoparticles (b) Reaction of ligands at nanoparticle surfaces (c) Interaction of ligands with nanoparticle environment	Review: Grubbs, R.B. *Polym Rev*., **2007**, 47:2, 197-215.
13	Functionalization of nanoparticles in biomedical application (a) Ionic and steric stabilization (b) Ligand exchange: O, N, P, S-based ligands	Review: Thanh, N.T.K., et al., *Nano Today*. **2010**, 5, 213-230
14	(c) Core shell structures (d) Effect of ligand shell on physical and biomedical properties (e) Biofunctionalization: nucleic acids, proteins, peptides, phospholipids, carbohydrates	Review: Bao, G. et al. *Nanomedicine*. **2016**, 11, 673-692.
15	Special topic: Nanoparticles in theranostic (a) Introduction and historical emergence (b) Brief introduction of imaging modalities (c) Brief introduction of therapeutic modalities (d) Advantages of nanoparticles for diagnostic and therapeutics	Review: Gambhir S.S. et al., *Acc. Chem. Res*. **2011**, 44, 1050-1060
16	(e) Nanoparticle types Case study: Design of nanoparticle for theranostic	
17	Student research presentation	
18	Student research presentation	