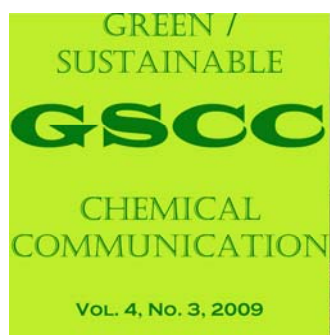


綠色/永續化學通訊
**Green/Sustainable
Chemical Communication**

Vol. 4, No. 3, 2009



國科會化學中心



綠色/永續
化學通訊

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GUEST LETTER

從一位高中化學教師的觀點出發,如何讓綠色/永續化學觀念在校園紮根

北一女中 化學科 周芳妃

高中化學教學往往首要考慮高中生的升學需求，因此高中化學教師均會密切注意每年大考中心在大學招生的學測及指考命題內容的各種重要概念。95 學年度(2006 年)指定科目考試試題化學考科單選題第 7 題出現當時所謂的時事題¹：「綠色化學的概念強調化學製程中原子的使用效率，若製程中...試問使用丙酮製程的原子使用效率，最接近下列哪一項？」。自此，「綠色化學」(Green Chemistry) 四個字就堂堂皇皇進入了所有高中化學教師的教案及講義中。

為人師表者，時時讓學生從教師言行觀察體會做人做事的道理之外，高中化學教師在本科專業領域肩負許多重要責任，包括基礎知識的教學、實驗技能的培養、實驗安全的教育、及當代科學概念的傳播推廣等。在目前高中化學教學中，「奈米科技」、「生命科學」及「綠色/永續化學」可說是最夯的當代科學概念。我國高中化學課程綱都是集合國內化學學者與高中教師共同擬訂，在 87-94 年課程綱要與現行的 95 年暫綱的高中基礎化學課程中，雖安排了環境汙染防治與再生能源等課程，但在明年即將實施的 99 新課綱中，才正式將「綠色/永續化學」相關名詞納入基礎化學的課綱，引用如下²：

高級中學基礎化學（二）			
主題	主題內容	應修內容	說明（參考節數：2 小時）
化學應用	四、化學與 化工	1. 生活中的化學 2. 化學與永續發展 3. 化學與先進科技	<ul style="list-style-type: none"> • 簡介化學、化工與日常生活的關係 • 簡介化學、化工對環境永續發展的重要 • 簡介化學、化工對先進科技發展的重要

迎接高中化學 99 新課綱的同時，也須考慮如何讓「綠色/永續化學」觀念在校園紮根。教育部成立已有數年的高中化學學科中心，目前發展為國內許多高中化學教師合作研發及傳播知識的團隊。該中心也兼顧了高中生的科學社群活動，今年舉辦的第三屆高中生化學創意競賽，與義守大學(2009 化學年會主辦單位)合辦『全國高中生科普論文寫作和數位影音製作』(簡稱 2009 WE CAN)，設定五個競賽主題³：環保科技、綠色化學、永續發展、再生能源、節能減碳。凡事起頭最難，今年 9 月份推廣活動期間，動員國內不少高中化學教師協助鼓勵學生在繁忙課業中能勇敢參賽，但是許多高中生忙於應付校內段考而分身乏術。目前



11 月份這項活動適逢收件階段，得獎學生將在 2009 年 12 月的化學年會中接受頒獎。由於高中生難得能在化學年會接受頒獎，這是本活動給予最特殊的榮譽。如果今年此活動一切順利，並有國內化學界協助加持及宣傳，則明年帶動國內高中生學習思考「綠色/永續化學」觀念的風氣應可更為蓬勃。

每年國內蓬勃熱鬧的地區性及全國科展比賽，也幾乎是每位高中化學教師都必須經歷的工作經驗。國內擔任科展評審的許多化學學者的評審標準，都會直接影響後續數年的科展研究方向。歷年來的科展評審很早就重視到「綠色/永續化學」觀念在高中化學教育的重要性，獲獎作品中許多都是落實「綠色/永續化學」的精神並應用於解決問題。以筆者的學生為例，有學生曾研究以一隻小小的毛細管裝置，完成化學課本中許多熱分解實驗，並應用開發七彩煙火配方，以「Green Chemistry—當毛細管遇上煙火」為題，榮獲我國參加南非國際科展正選代表(1997 年)。也有學生曾研究以 1 mL 塑膠滴管改裝的電解裝置，探討各種氯化物水溶液電解的現象，以「氫山氯水」為題，榮獲全國科展化學科第二名(1999 年)。這些歷屆獲獎作品都收納在國立台灣科學教育館的網頁中^{4,5}，皆成為後續科展研究的觀摩對象，一年復一年，傳承「綠色/永續化學」精神。

閱讀能力是高中生畢業後能終生帶著的重要學習能力。國內許多科教相關網路資源提供許多「綠色/永續化學」相關資料，這些精彩的文章提供為高中化學教師自我進修的功課，有些也適合安排給學生作為學期作業的閱讀學習資料，或是設計於課堂討論課程中。國內有名的科普雜誌，如科學月刊及科學人雜誌等，其與「綠色/永續化學」相關內容也很多，但是限於篇幅，在此不引述。在此整理一些官方或學術單位網址，以「綠色化學」或「綠色」為關鍵字所查詢結果，平時在家就可以點選並直接下載的資料。下表中，化學季刊(2007 年)專文介紹由國科會化學中心及中央研究院化學所製作的本「綠色/永續化學網路資源共享網」。

(1) 國立台灣大學科學教育發展中心/高瞻計畫資源平台⁶

- 綠色化學 (Green Chemistry) 總論
- 綠色化學 (Green Chemistry) 大挑戰
- 綠色化學 (Green Chemistry) 與原子經濟 (Atom Economy)
- 綠色化學 (Green Chemistry) 與水相反應 (Reaction in Aqua Media)

(2) 國科會出版品/科學發展⁷

- 超臨界萃取的應用 (2009 年)
- 微藻---綠色生質能源 (2009 年)
- 綠色能源催化者——燃料電池中的鉑鈦觸媒 (2007 年)
- 無所不在的環境清潔工—奈米光觸媒 (2006 年)
- 綠色醫藥—是傳統還是新科技 (2006 年)
- 化學中的清流--對環境友善的綠色化學 (2005 年)
- 未來的綠色能源---燃料電池 (2005 年)
- 綠色消費的國際發展趨勢 (2005 年)
- 綠色化學，自然就是美 (2002 年)



- 淺談環境保護與工程設計－綠色工程設計與綠色行銷（2001年）

(3) 中國化學會/化學季刊⁸

- 創意微型化學實驗之設計研發與在技術校院科學通識教育上之應用研究（2008年）
- 利用三相系統-水/離子液體/超臨界流體二氧化碳萃取金屬(2008年)
- 綠色化學的產業技術（2007年）
- 室溫下零溶劑零催化劑的 Hantzsch 反應的產物之綠色合成方法（2007年）
- 綠色化學在藥物化學上的應用（2007年）
- 沸石於環境友善性線性烷基苯生產製程之催化應用（2007年）
- 綠色化學：生態材料開發與應用（2007年）
- 微奈米材料的綠色合成法（2007年）
- 綠色分析化學（2007年）
- 綠色/永續化學網路資源共享網之旅（2007年）
- 零污染安全微型氯氣製備裝置之設計及化學教學演示之研究（2003年）
- 中學微型木材乾餾有機化學實驗之設計（2002年）

參考網址：

1. 大學入學考試中心 95 學年度試題
<http://www.ceec.edu.tw/AppointExam/AppointExamPaper/95ApExamPaper.htm>
2. 普通高級中學必修科目「基礎化學」課程綱要
http://www.edu.tw/files/site_content/B0037/高中課程綱要修正發布.pdf
3. 全國高中生科普論文寫作和數位影音製作創意競賽
<http://www1.isu.edu.tw/2009wecan/>
4. 國立台灣科學教育館/台灣國際科學展覽會
<http://www.ntsec.gov.tw/ml.aspx?sNo=0000168>
5. 國立台灣科學教育館/全國中小學科學展覽會
<http://www.ntsec.gov.tw/ml.aspx?sNo=0000167>
6. 國立台灣大學科學教育發展中心/高瞻計畫資源平台
<http://highscope.ch.ntu.edu.tw/>
7. 國科會出版品/科學發展
http://ejournal.stpi.org.tw/NSC_INDEX/Journal/EJ0001/index.html
8. 中國化學會/化學季刊/化學電子期刊搜尋
http://chemistry.org.tw/public_quar_query.php



RESOURCE SHARING

緩和地球暖化的八個非『傳統』方法

現代人大多瞭解石油供應日漸枯竭，石油所釋放出的溫室氣體二氧化碳造成地球暖化，導至氣候異常，嚴重危害了人類的生存。

目前科學家已提出許多解決方案。這些方案在提出之前大多已將『社會大眾的接受度』做為前題之一。所以大家都能耳熟能詳。現在要介紹八個不太『傳統』的建議或方法，看起來也許有些叛經背道，但很難說沒有包涵將來解決地球暖化之道。特此予以披露。供大家參考。

1. 地球暖化使南北極的冰川、冰谷融化，使海平面升高，氣候變化。所以降低了冰河的融化速度是當務之急。若把格陵蘭用氈子蓋起來，氈子下的山谷受不到陽光，當然就不會融化，自然減低暖化的速度。這是俄亥歐州立大學冰川學家 Jason Box 博士提出的點子。
2. 夏威夷大學的海洋生物學家 Brian von Herzen 博士認為可用大型抽水機將極富養分的海洋深層水抽上來和暖和的表面水混合，然後大量繁殖浮游生物，植物生長需二氧化碳，如此海洋可大量貯集二氧化碳，可以降低大氣中二氧化碳之量。
3. 曾協助製造全世界最大望遠鏡的 Roger Angel 教授建議做一個 100000 平英哩的遮陽板，可以降低日照 2%。地球暖化將變慢。
4. 森林可吸收二氧化碳提供氧氣。多植樹是防止地球暖化的好方法之一，這是眾所週知的。問題是如何廣植樹木？尤其是人煙罕至的地方。環境工程師 Mark Hodges 提出一個點子。將樹種包在一裝滿肥料的蠟罐中，用飛機去植樹。將蠟罐由空中丟下。蠟罐在碰撞地面時裂開，於是肥料流出來可供給種子生長之用。據說此法已用在被 Katrina 颶風重創的路易士安那州。
5. 加拿大飛行器工程師 Fred Ferguson 設計一風力渦輪機，它可以利用在 1000 英尺高空的穩定氣流來發電。有了這潔淨的風能就不必用石化燃料。
6. 愛丁堡大學工程師 Stephen Salter 相信雲可遮住陽光(這和第三點很相似)，所以他建議在海洋的上空撒鹽，造雲來減少海水的蒸發。

7. 前太空總署物理學家建議發射千百個衛星至太空，每個衛星收集太陽光後再以微波的方式傳回地球。可不用或減少使用石化能源。
8. 擁有 2006 年加拿大地球環境科學家頭銜的 David Keith 相信吸入空氣和氫氧化鈉後再噴出來，就像灑空氣芳香劑一樣。空氣中的二氧化碳能被捕捉並存入地下。

不管你同不同意氣候的變遷起因人為的，但氣候在變是事實。所以我們不能眼睜睜的看它變壞下去。所以每個人都應依自己的專長貢獻一份心力。

(甘魯生教授 改寫)

(摘自 Telegraph.co.uk 新聞稿(6:35PM GMT 13 Feb 2009))。

永續化學的教育(Education in sustainable/green chemistry)

(台大名譽教授劉廣定)

(1)永續化學講課參考資料:

Green Chemistry: A design framework for sustainability

In this review we will highlight some of the science that exemplifies the principles of Green Chemistry, in particular the efficient use of materials and energy, development of renewable resources, and design for reduced hazard. Examples are drawn from a diverse range of research fields including catalysis, alternative solvents, analytical chemistry, polymer science, and toxicology. While it is impossible for us to be comprehensive, as the worldwide proliferation of Green Chemistry research, industrial application, conferences, networks, and journals has led to a wealth of innovation, the review will attempt to illustrate how progress has been made toward solving the sustainability goals of the 21st century by engaging at the molecular level.



Evan S. Beach, Zheng Cui and Paul T. Anastas, *Energy Environ. Sci.*, **2009**, 2, 1038 – 1049.

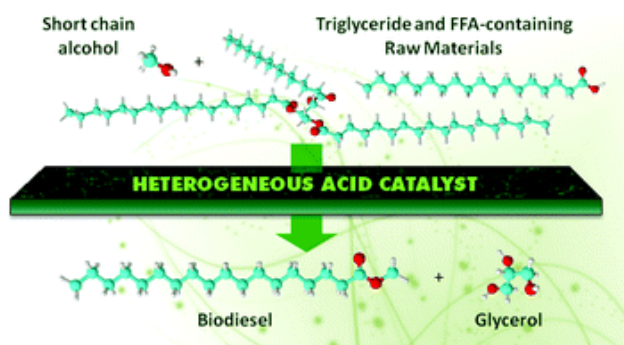


Heterogeneous acid catalysts for biodiesel production: current status and future challenges

The reduction of oil resources and the consequent increasing price of oil distillates as well as the environmental concerns of conventional fuels has renewed

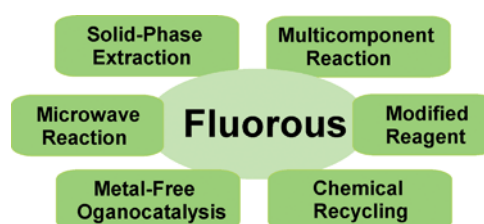
and increased interest on the preparation of biofuels from renewable resources. One of those interests is nowadays focused on biodiesel, which is usually prepared from crude and refined triglyceride containing raw materials, such as vegetable oils, animal fats and wastes—for instance waste cooking oil and yellow and brown grease. Since several commercial interests converge on this kind of feedstock, one of the priorities being crops for human food supply, the research efforts on biodiesel production are diverting towards the use of low quality triglyceride-containing raw materials. Nevertheless, all of these feedstocks feature high water and free fatty acids (FFAs) content, which strongly affects the behaviour of conventional homogeneous base catalysts. These catalysts are primarily NaOH and KOH, but also NaOCH₃ and KOCH₃ are employed—as solutions in methanol—mainly in large-scale production plants. In this context, an appropriate solid acid catalyst which could simultaneously carry out esterification of FFAs and transesterification of triglycerides would be of great interest for biodiesel production. Moreover, a heterogeneous acid catalyst could be easily incorporated into a packed bed continuous flow reactor, simplifying product separation and purification and reducing waste generation. The present review attempts to provide a wide overview on the possibility of heterogeneous acid catalysts for biodiesel production replacing the homogeneous conventional process. In this way, three aspects of solid acid catalysis for biodiesel production will be reviewed. The first section deals with the solid acid-catalyzed esterification of FFAs, the second topic relates to the transesterification of triglycerides, while the third deals with solid acid-catalyzed transformation of bioglycerol into oxygenated compounds for biodiesel formulation.

Juan A. Melero, Jose Iglesias and Gabriel Morales, *Green Chem.*, **2009**, *11*, 1285 – 1308.



Green chemistry aspects of fluororous techniques—opportunities and challenges for small-scale organic synthesis

Described in this paper is a personal overview of the green chemistry aspects of fluororous technologies. The unique phase separation



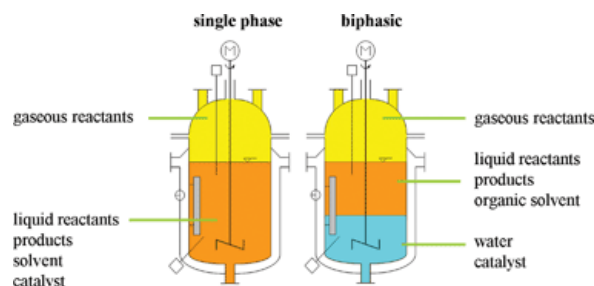


and broad combinatorial capabilities of fluororous technologies have led to the development of fluororous chromatography-free separations, chemical recycling techniques, atom economic reactions, energy-focused microwave reactions, metal-free organocatalysis, aqueous media reactions, and modified reagents. These green chemistry techniques have been demonstrated in discovery chemistry, medicinal chemistry, and academic research labs dealing with small-scale organic synthesis. Issues such as the environmental impact of fluororous chemicals are also discussed. Wei Zhang, *Green Chem.* **2009**, *11*, 911 – 920.

Application of the solvent water in two-phase telomerisation reactions and recycling of the homogeneous palladium catalysts

In the chemical industry organic solvents should be avoided wherever possible. They are often toxic to marine organisms and plants as well as to higher organisms and humans. Moreover, volatile organic compounds (VOC) cause air pollution which

leads to the necessity of expensive separation technologies like waste water or exhaust gas treatments. Solutions for these problems are either the development of processes without the use of any solvent or the use of environmentally benign solvents such as water. In this contribution it is shown how versatile water can be, used as a



solvent in homogeneously catalysed processes, for example, telomerisation reactions with methanol, diethylamine, ethylene glycol and glycerol. In this context another positive effect of the solvent water is the ecologically and economically required retention of the transition metal catalyst inside the process. Furthermore, different reactor types, a loop reactor and a mixer-settler reactor, are presented to cope with the challenges of mass transport limitations and selectivity control in aqueous biphasic systems.

Arno Behr and Julia Leschinski, *Green Chem.* **2009**, *11*, 609 – 613.

Plastic alchemy

In this essay the author describes:

1. Dumping plastics after use is looking increasingly untenable, and it being increasingly seen as a waste of a valuable resource.
2. Different plastics need recycling differently - and sorting can be costly.
3. Color impurities dramatically affect the resale value of recycled plastic, so waste often also needs to be sorted by color.
4. Scientists are researching ways to strip out the color during reprocessing.



Andy West, *Chemistry World* **2009**, 6(9), 52-55.

The artificial leaf

Using sunlight to split water molecules and form hydrogen fuel is one of the most promising tactics for kicking our carbon habit. It was indicated that sunlight could provide all our energy needs if it could be efficiently harnessed to make hydrogen from water. However, the water-splitting machinery is highly complex, and so difficult to mimic. Metal-based catalysts that capture sunlight to split water are still too inefficient to be practical. Combining electrochemically driven water-splitting catalysts with solar cells could circumvent the problem.

Hayley Birch, *Chemistry World* **2009**, 6(5), 42-46.

The biofuel future

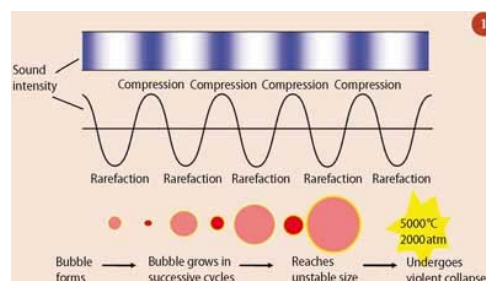
The chemistry to convert waste into fuels is now being tested at pilot plants around the world. Its current situation and the future development, especially about governments and industry were briefly described.

Emma Davies, *Chemistry World* **2009**, 6(4), 40-43.

Sonochemistry - beyond synthesis

Sonochemistry began with the discovery that simple ultrasonic cleaning baths could be used to influence a range of chemical reactions. Since then the field has expanded outside of chemical synthesis and now finds applications in the food industry medicine, nanoscience and environmental remediation.

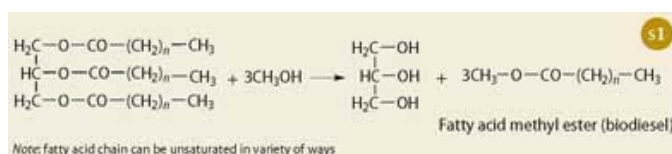
Timothy J. Mason, *Education in Chemistry* **2009**, 46, 140-144.



Biofuels: the next generation

First-generation biofuels made from carbohydrate-rich food crops, such as corn or sugar cane, have come under scrutiny as they compete with food crops for land use. Chemists are now turning their attention to dead wood, algae and genetically-engineered microorganisms to develop second-generation biofuels.

Michael Gross, *Education in Chemistry* **2009**, 46, 78-81.



Crop protection chemicals



By 2030, the world's population is expected to rise from the current 6.7 billion to over eight billion. As a consequence much agricultural land will be lost under cities and roads. This, coupled with economic growth across Asia, and a renewed focus on biofuels, is putting increasing pressure on food supplies and a growing demand for higher crop yields. The need for safe and environmentally-friendly crop protection

chemicals has never been greater.

Sarah Armstrong and John Clough, *Education in Chemistry* **2009**, 46, 52-56.

Method for manufacturing enterodiol and enterolactone by anaerobic culture

The title method is performed by carrying out anaerobic ferment of intestinal bacteria with at least one of linseed meal, seaweed, sesame meal, rapeseed meal, Secale cereale bran, wheat bran, Hordeum vulgare bran, Zea mays bran, Avena sativa bran, and Arctium lappa meal as the substrate. The method has the advantages of easy purifn. process, high product enterodiol and enterolactone contents (70.15-91.12%), easy operation, low cost, and no environmental pollution, and is suitable for industrial production.

Yang, Donghui; Liu, Shulin; Ku, Baoshan. Faming Zhuanli Shenqing Gongkai Shuomingshu (發明專利申請公開說明書) (2009).

Preparation some 1-n-alkyl-3-methylimidazolium tetrafluoroborate in green chemistry conditions

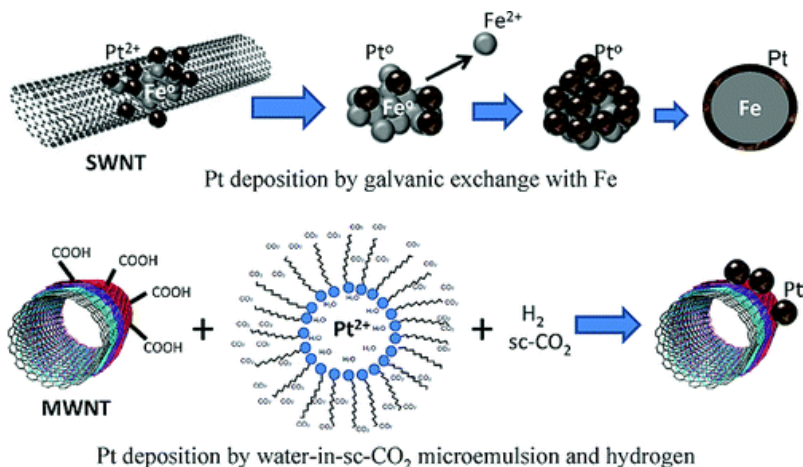
In this paper we described the prepn. of some 1-n-alkyl-3-methylimidazolium tetrafluoroborates ([Cnmim]BF₄ with Cn is Et, Bu, n-hexyl, n-octyl resp.) in Green Chem. conditions. All starting materials were used in stoichiometric quantities; the reactions were activated by microwave or ultrasound in solventless media. Firstly, alkylimidazolium bromides were prepd. from the N-alkylation of N-methylimidazole with a n-alkyl bromide corresponding. After that, tetrafluoroborate furnished a metathesis with bromide to give the final products. Comparing with conventional heating, the obtained yield was higher and the reaction time was shorter under microwave irradiation.

Nguyen, Thi Mai Huong; Le, Ngoc Thach. Tap Chi Hoa Hoc (註：越南文：有機化學) (2009), 47(2), 154-161.



Application of Green Chemistry Techniques to Prepare Electrocatalysts for Direct Methanol Fuel Cells

A series of green techniques for synthesizing carbon nanotube-supported platinum nanoparticles and their high electrocatalytic activity toward methanol fuel cell applications are reported. The techniques utilize either the supercritical fluid carbon dioxide or water as a medium for depositing platinum



nanoparticles on surfaces of multiwalled or single-walled carbon nanotubes. The catalytic properties of the carbon nanotubes-supported Pt nanoparticle catalysts prepared by four different techniques are compared for anodic oxidation of methanol and cathodic reduction of oxygen using cyclic voltammetry. One technique using galvanic exchange of Pt²⁺ in water with zerovalent iron present on the surfaces of as-grown single-walled carbon nanotubes produces a Pt catalyst that shows an unusually high catalytic activity for reduction of oxygen but a negligible activity for oxidation of methanol. This fuel-selective catalyst may have a unique application as a cathode catalyst in methanol fuel cells to alleviate the problems caused by crossover of methanol through the polymer electrolyte membrane.

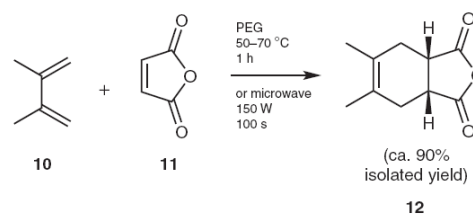
Shimizu, Kenichi; Wang, Joanna S.; Wai, Chien M. J. *J. Phys. Chem. A*, Article ASAP, DOI: 10.1021/jp907395z, Publication Date (Web): October 14, 2009

(2) 學生實驗參考資料:

(台大名譽教授劉廣定)

Greener Solutions for the Organic Chemistry Teaching Lab: Exploring the Advantages of Alternative Reaction Media

A major approach for implementing green chemistry is the discovery and development of synthetic strategies that reduce the quantity of solvent needed, eliminate it altogether, or rely on new reaction media. An increasing number of



Scheme IV. Diels-Alder reaction of 2,3-dimethyl-1,3-butadiene, 10, with maleic anhydride, 11, in PEG solvent.

examples have demonstrated that greener reaction solvents or media can enhance performance as well as reduce hazard. Four experiments designed for the undergraduate organic chemistry laboratory that illustrate both enhanced performance and a greener approach were discussed: (i) a solventless aldol condensation that involves the reaction of two solid reagents, (ii) a solvent-free, room temperature Diels–Alder reaction followed by an intramolecular nucleophilic acyl substitution, (iii) a Diels–Alder reaction in water, and (iv) a Diels–Alder reaction in polyethylene glycol (PEG) that may be conducted using microwave heating.

“Instructions for the students” and “Notes for the instructor” are available as supplemental materials.

Lallie C. McKenzie, et al. *J. Chem. Educ.* **2009**, *86*, 488-493.

Zeolite 5A Catalyzed Etherification of Diphenylmethanol

An experiment for the synthetic undergraduate laboratory is described in which zeolite 5A catalyzes the room temperature dehydration of diphenylmethanol, $(\text{C}_6\text{H}_5)_2\text{CHOH}$, producing 1,1,1',1'-tetraphenyldimethyl ether, $(\text{C}_6\text{H}_5)_2\text{CHOCH}(\text{C}_6\text{H}_5)_2$. The reaction proceeds in good yield and purity, and the product is readily characterized by the conventional spectroscopic methods that are normally available to undergraduate students in synthetic chemistry laboratories.

“Instructions for the students” and “Notes for the instructor” are available as supplemental materials.

Jason Cooke, et al., *J. Chem. Educ.* **2009**, *86*, 610-612.

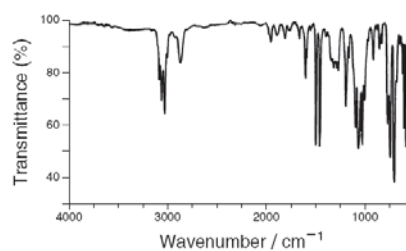
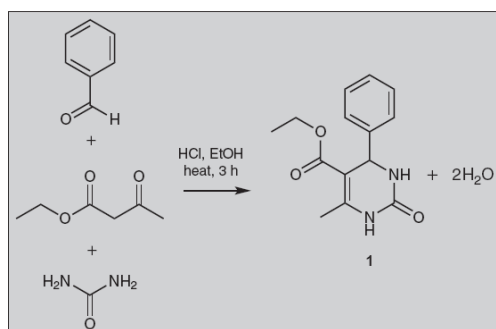


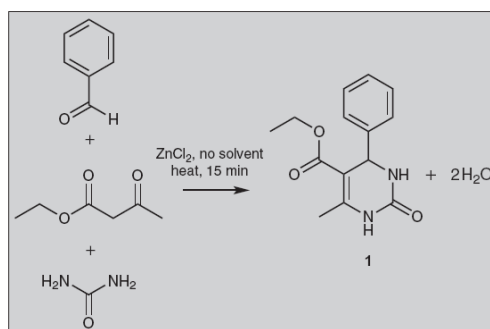
Figure 1. FTIR spectrum of $(\text{C}_6\text{H}_5)_2\text{CHOCH}(\text{C}_6\text{H}_5)_2$ [cast film from CH_2Cl_2].

Comparing the Traditional with the Modern: A Greener, Solvent-Free Dihydropyrimidone Synthesis

A microscale organic synthesis experiment is outlined where students undertake both



Scheme I. A traditional Biainelli synthesis.



Scheme II. A modern Biainelli synthesis.

a "traditional" and "modern" Biginelli preparation of a dihydropyrimidone, within the



same three-hour session. Each method is straightforward, appropriate as part of a mid-level undergraduate laboratory, and performed individually or between a pair of students. Emphasis is placed on comparing approaches from a green chemistry perspective. The class probes concepts of catalytic reactivity, solvent-free synthesis, atom economy, and energy consumption to assess green improvements made by employing the modern strategy.

“Instructions for the students,” “Notes for the instructor,” spectroscopic and physical data are available as supplemental materials.

Evangelos Aktoudianakis, et al., *J. Chem. Educ.* **2009**, *86*, 730-732.

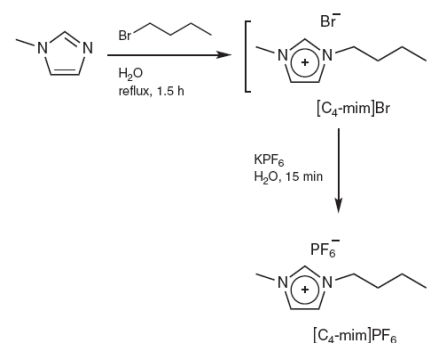
Synthesis of Imidazolium Room-Temperature Ionic Liquids

Room-temperature ionic liquids have become a widely used alternative to conventional molecular organic solvents as a reaction medium. Few preparations of ionic liquids provide efficient access to these solvents; furthermore, none is fully adaptable to an undergraduate organic chemistry laboratory. In this article, several imidazolium-based ionic liquids are formed in facile and efficient one-pot procedures using water or ethanol as a solvent. These reactions are suited for a four-hour organic chemistry laboratory without special equipment.

These reactions are suited for a four-hour organic chemistry laboratory without special equipment.

“Instructions for the students,” “Notes for the instructor,” spectroscopic and physical data are available as supplemental materials.

Sergei V. Dzyuba, et al. *J. Chem. Educ.* **2009**, *86*, 856-858.



Scheme 1. One-pot synthesis of [C₄-mim]PF₆ ionic liquid.

A Theme-Based Course: Hydrogen as the Fuel of the Future

A theme-based course focusing on the potential role of hydrogen as a future fuel is described. Numerous topics included in typical introductory courses can be directly

Table 2. Cost of Generating Hydrogen from the Active Metals Compared with Electrochemical Generation and Gasoline

Active Metal	Metal Cost			Molar Mass of Metal/ (g/mol)	Electrons per Metal	Electron Cost/ (\$/mol)	Cost ^a / (\$/tank)	Fuel Cost ^f (\$/mi)
	\$/lb	\$/kg	\$/mol					
Mg	3.00	6.61	0.161	24.3	2	0.0804	305	1.91
Al	1.52	3.35	0.0904	27.0	3	0.0302	115	0.72
Zn	0.40	0.88	0.0576	65.4	2	0.0288	110	0.68
Battery ^c							58,800	368
Household electricity ^d							104	0.65
Gasoline ^e							32	0.20

^aTank cost based on 3.8 kg of hydrogen or a range of 160 mi. ^bA hydrogen-powered car with a 3.8 kg tank of hydrogen that runs 160 miles. ^cbatteries cost \$30. ^dThe household electricity costs \$0.17 per kW h. ^eGasoline costs \$4.00 per gallon and the car has an 8-gallon tank and gets miles per gallon.

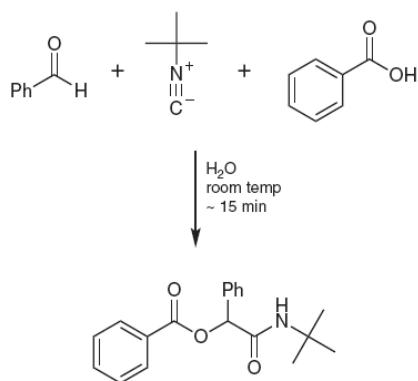
related to the issue of hydrogen energy. Beginning topics include Avogadro's number, the mole, atomic mass, gas laws, and the role of electrons in chemical transformations.

Reaction stoichiometry and exchange of electrons in a reaction are reinforced through discussions of using electrolysis or active metals to generate hydrogen. Molecular structure, molecular orbitals, and semiconductors are involved in using solar energy to generate electricity that can liberate hydrogen from water. Thermodynamics is applied in considering both gravimetric (energy per unit mass) and volumetric (energy per unit volume) energy density. Data are presented indicating that student performance is enhanced when introductory concepts are conveyed via this theme-based approach.

Mary Jane Shultz, et al., *J. Chem. Educ.* **2009**, *86*, 1051-1053.

A Green Multicomponent Reaction for the Organic Chemistry Laboratory: The Aqueous Passerini Reaction

Water is the ideal green solvent for organic reactions. However, most organic molecules are insoluble in it. Herein, we report a laboratory module that takes advantage of this property. The Passerini reaction, a three-component coupling involving an isocyanide, aldehyde, and carboxylic acid, typically requires ~ 24 h reaction times in organic solvents, but produces a quantitative conversion and yield in < 30 min when performed in water. This rate enhancement allows the Passerini reaction to be easily adapted for use in a second-year organic laboratory course.



Scheme 1. The Passerini reaction examined in this lab.

Additionally, the incorporation of this laboratory module facilitates discussions of both green chemistry and combinatorial chemistry in the curriculum.

“Instructions for the students,” “Notes for the instructor,” spectroscopic and physical data are available as supplemental materials.

Matthew M. Hooper and Brenton DeBoef, *J. Chem. Educ.* **2009**, *86*, 1077-1079.

美國化學會 2009 年暑期講習會

ACS Summer School on Green Chemistry and Sustainable Energy

Graduate students and postdoctoral scholars explore scientific solutions to global challenges at the ACS Summer School on Green Chemistry and Sustainable Energy. Transportation, meals, and housing are provided. Participants will:



- Hear presentations by leading researchers in sustainability and green chemistry
- Collaborate on problem solving projects
- Participate in laboratory experiments
- Present your research during poster sessions
- Engage in discussions on the role of science and technology in solving global sustainability challenges

The 2009 program was held July 22-30 at the Colorado School of Mines. There were 13 lectures as listed below.

1. **Greening the Pharmaceutical Industry**
Berkeley W. Cue, BWC Pharma Consulting LLC
2. **Technologies for the Pharmaceutical Manufacturing Plant of the Future (In Search of the Science of Scale)**
Berkeley W. Cue, BWC Pharma Consulting LLC
3. **Metrics Gone Wild**
Eric Beckman, University of Pittsburgh
4. **Eco-Innovation & Product Design**
Eric Beckman, University of Pittsburgh
5. **Green Solvents**
Philip Jessop, Queen's University
6. **Inspired by Nature and Some Other Stuff**
Thomas H. Lane, Dow Corning Corporation
7. **Value of Green Chemistry in a Business Environment**
Roger McFadden, Staples Inc.
8. **Nanoscale Materials and Catalysis**
Ryan Richards, Colorado School of Mines
9. **A Sustainable Energy Future**
John A. Turner, National Renewable Energy Laboratory
10. **The Story of our Sustainability**
Katie Wallace, Sustainability Specialist
11. **Green Chemistry: The Molecular Science of Sustainability**
John C. Warner, The Warner Babcock Institute for Green Chemistry
12. **Green Chemistry and Entropic Control in Materials and Processes**
John C. Warner, The Warner Babcock Institute for Green Chemistry
13. **Green Separations**
Kim R. Williams, Laboratory for Advance Separations Technologie

Speaker' presentations could be downloaded from website :

<http://portal.acs.org/portal/acs/corg/content>, then click "ACS Green Chemistry Institute," and then "Green Chemistry Education.

大陸各級學校 2009 年有關永續化學的一些研究報告

由於下載原文常需時較久，故只在下表中列出「題目」、「作者」、「期刊名（或書名）」以及期別，以供參考。

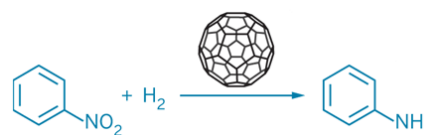
	篇名	作者	期刊（書）名	期別
1	五年制高職藥學專業《分析化學》教學改革的探索	李春	中國科技信息	2009/15
2	化學實驗綠色化研究	笄良國	淮南師範學院學報	2009/03
3	綠色化學理念在高等化學教育中的融入	胡明星	黑龍江高教研究	2009/07
4	綠色化學實驗中計算機技術的應用	張增	高等函授學報(自然科學版)	2009/03
5	在化學教學中有效實施綠色化學教育	王盟	教育導刊	2009/06
6	從化學教材中向學生挖掘和介紹綠色化學	李國海	科技信息	2009/15
7	模擬化學實驗室在農業院校綠色化學教育中的優勢與作用	凌育趙	安徽農業科學	2009/19
8	《化學電源》課程教學中綠色化學理念的滲透	呂東生	廣州化工	2009/03
9	有機化學實驗綠色化教學模式改革的初步研究	寧靜恒	廣東化工	2009/06
10	在化學實驗中實現綠色化學的幾點做法	岳秀俠	安慶師範學院學報(自然科學版)	2009/02
11	綠色化學理念下有機化學實驗教學課件設計原則探討	庾江喜	黑龍江科技信息	2009/22
12	在染整專業中滲透綠色化學教育	孫華	浙江紡織服裝職業技術學院學報	2009/02
13	綠色化學簡釋及其應用舉例	秦宗余	中學生數理化(高一版)	2009/03
14	化學教學與環保教育相結合的一點思考	李金東	科技資訊	2009/06
15	高中化學教學中滲透環境教育的途徑和方法	王桂艷	中國教育技術裝備	2009/08
16	高職化學教學中滲透綠色化學教育的再思考	許新兵	中國科技信息	2009/10
17	在高中化學實驗中培養綠色化學觀的教育探索	馬志成	天津師範大學學報(基礎教育版)	2009/01
18	高校化學教學中綠色化學教育的實踐與探索	唐娜	中國科教創新導刊	2009/13
19	潮州市中學化學實驗綠色化調查研究	邱賀媛	廣東化工	2009/03
20	高職院校開設綠色化學選修課的探索與實踐	張增	中國校外教育(理論)	2009/03
21	中等職業學校實施綠色化學教育的策略	孔凡珍	中國校外教育(理論)	2009/01
22	農科院校化學教學中滲透綠色化學理念的思考	王豐	吉林農業科技學院學報	2009/01
23	綠色化學理念應用於教學實踐的方法探究	王豐	畜牧與飼料科學	2009/02
24	高校綠色化學初探	劉雲鶴	科學大眾	2009/01
25	綠色化學在高職化學教育中的教學探討	張西安	開封教育學院學報	2009/01
26	實驗室廢液處理及減少污染的措施	陳素霞	河南化工	2009/04
27	加強化學實驗綠色化教育培養學生環保意識	鄒敏	藥學教育	2009/01
28	《有機化學》教學改革的探討	胡智學	廣州化工	2009/01
29	實施中學綠色化學教育的途徑	滑志軍	現代教育科學(中學教師)	2009/01
30	綠色化學與創造性教學	樂傳俊; 顧黎萍	化學教育	2009/03
31	有機化學實驗的綠色化路線設計	紀明慧等	化學教育	2009/03



RESEARCH BREAKTHROUGHS

Hydrogenation Without Metals

Fullerenes can catalyze hydrogenation of organic compounds as effectively as metals can, according to a study by researchers in China (*J. Am. Chem. Soc.*, DOI: 10.1021/ja9061097). The discovery may lead to replacing precious-metal catalysts with carbon-based substitutes, which could reduce costs and the environmental effects of heavy-metal pollutants.



Irradiating nitrobenzene in the presence of a fullerene catalyst yields nearly 100% aniline.

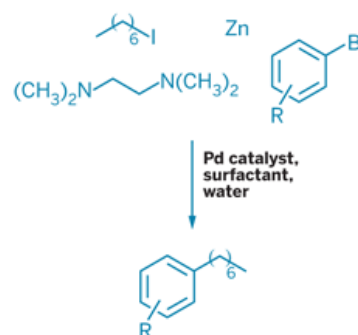
Fullerene can activate molecular hydrogen and is a novel nonmetal hydrogenation catalyst. The hydrogenation of aromatic nitro compounds to amino aromatics is achieved on this catalyst with high conversion and selectivity under 1 atmospheric pressure of H₂ and light irradiation at room temperature or under conditions of 120–160 °C and 4–5 MPa H₂ pressure without light irradiation, which is comparable to the case with a noble metal catalyst.

(Chemical & Engineering News 2009,

<http://pubs.acs.org/isubscribe/journals/cen/87/i44/html/8744notw7.html>; *J. Am. Chem. Soc.*, **2009**, *131* (45), pp 16380–16382)

Cross-Coupling Made Easier----Green Chemistry: Organozinc reagents made on the fly in water simplify alkylations

An easier, greener route to aryl-alkyl cross-coupling reactions—one of the most indispensable types of reactions in organic synthesis—is being reported by [Bruce H. Lipshutz](#) and coworkers at the University of California, Santa Barbara (*J. Am. Chem. Soc.*, DOI: [10.1021/ja906803t](https://doi.org/10.1021/ja906803t)). The approach takes advantage of micelles as nanoreactors for the in situ generation of an alkylzinc reagent that sparks a standard palladium-catalyzed Negishi cross-coupling reaction. Using aqueous conditions and generating the organozinc reagent on the fly at room



R = various groups

In micellar solution, zinc diamine mediates palladium-catalyzed aryl-alkyl cross-couplings



temperature weren't thought to be possible for this type of cross-coupling before now. The strategy builds on Lipshutz' efforts to use nanomicelles as a medium for transition-metal-catalyzed reactions. Lipshutz, Arkady Krasovskiy, and Christophe Duplais made a micellar solution by dissolving in water one of Lipshutz' designer nonionic surfactants—the commercially available polyoxyethanyl α -tocopheryl sebacate.

(Chemical & Engineering News, October 26, 2009 Volume 87, Number 43p. 6; *J. Am. Chem. Soc.*, **2009**, *131* (43), pp 15592–15593).



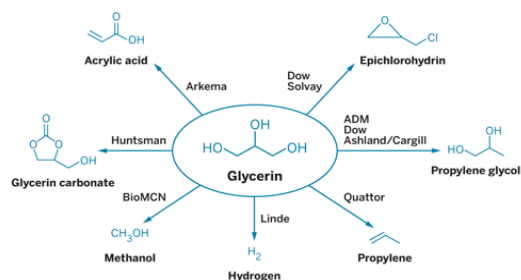
NEWS DIGEST

Glycerin Gambit

Making chemicals from the biodiesel by-product proves challenging.

LATER THIS MONTH, a new Dutch company called [BioMCN](#) plans to open a

BRANCHING OUT Glycerin is a potentially versatile chemical feedstock.



large-scale facility that will convert glycerin into methanol. The first of its kind, the plant is intended to take advantage of a surplus of glycerin in Europe and the rest of the world. This global excess is the result of the explosive growth of biodiesel as a renewable alternative to traditional diesel fuel. For every 10 gal of biodiesel

manufactured from vegetable oil, 1 gal of glycerin is produced on the side. Although making chemicals out of glycerin looked like a sure thing a few years ago, today it seems anything but. Even though the surplus is real and growing, glycerin has proven to be a volatile commodity that experiences huge price swings. At least one big glycerin-based chemical project has been shelved and two others are significantly delayed. Perhaps more ominously, questions are emerging about glycerin's long-term supply security. In the U.S., the biodiesel boom began in 2004, when then-president George W. Bush signed a jobs creation law that included a generous tax incentive to companies that produce biodiesel. According to the [National Biodiesel Board](#), U.S. biodiesel output tripled from 2004 to 2005 to 75 million gal. It continued to skyrocket for the next three years, reaching 700 million gal in 2008. Government mandates and incentives in Europe and Southeast Asia spawned similar biodiesel run-ups. Depending on the region, the

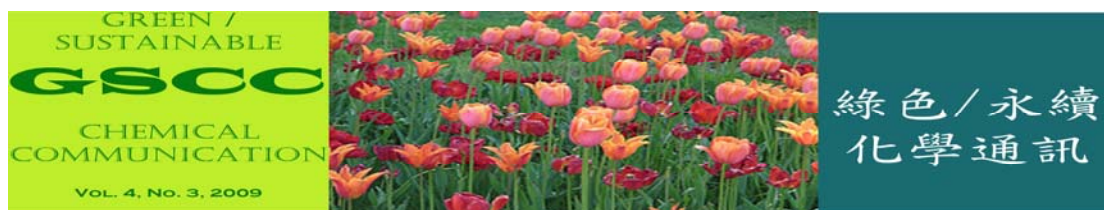


Renewables Debut BioMCN's glycerin-to-methanol plant starts up this month



Codexis. Communication between the companies includes discussions of further optimization and scale-up. "In our experience over the past few years, the issues of turnaround and scale-up are really nonexistent," Hughes says. "We can turn around results very quickly and really be assured that 99 times out of 100 we are going to have success." Success is tied in large part to the statistical protein sequence-activity relationship (ProSAR) technique that Codexis uses to optimize enzymes (*Nat. Biotechnol.* **2007**, 25, 338). As a result, the speed at which enzymes can be developed and delivered in kilogram quantities has risen dramatically, Huisman says, often taking only two to three months from inquiry to commercial biocatalyst.

(Chemical & Engineering News, March 16, 2009 Volume 87, Number 11pp. 14-16;
<http://pubs.acs.org/subscribe/journals/cen/87/i11/html/8711cover3.html>)

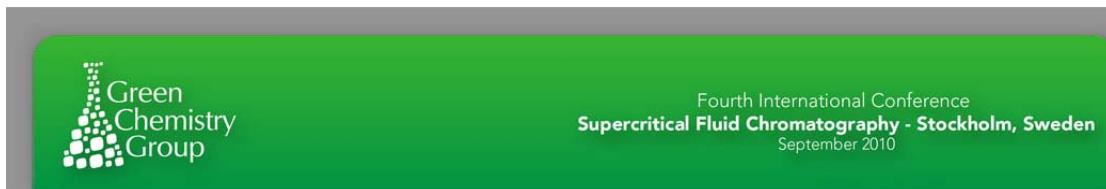


CONFERENCE INFORMATION

1. AAIC 21st Annual Meeting: 2009 International Conference: The Next Generation of Industrial Crops, Processes, and Products, Termas de Chillán, Chillán, Chile, November 14-19th, 2009 (http://www.aaic.org/2009_meeting.htm).
 
2. 2009 永續合成化學工作坊 will be held on Feb 1, 2010, TAIWAN. (Please contact Deputy Director Ito Chao in Institute of Chemistry, Academia Sinica for further information).
3. 14th Annual Green Chemistry & Engineering Conference: Innovation and Application---June 21-23, 2010, Capital Hilton, Washington, DC
 
4. Gordon Research Conference---Green Chemistry, July 25-30, 2010, Davidson College, Davidson, NC
5. 3rd International IUPAC Conference on Green Chemistry, August 15-19, 2010, Ottawa Westin Hotel, Ottawa, Canada (<http://www.icgc2010.ca/>)
 
6. Fourth International Conference on SFC 2010, Stockholm, Sweden - September 2010. With the growth of supercritical fluid chromatography as a cutting edge



technology, this conference provides a forum for new developments and applications. The Green Chemistry Group, a non-profit corporation, is dedicated to promote and encourage green and sustainable chemistry, including green analytical and purification techniques throughout the world.



7. 3rd International Symposium on Green Processing in the Pharmaceutical and Fine Chemical Industries---University of Massachusetts Boston, Boston, MA, Sept. 30-Oct. 1, 2010.





Opportunity

Programming Announcement

Nat. ACS Meeting -San Francisco -March 21-25, 2010

Looking for speakers for the following symposia

Organizers of programming for the National ACS meeting next spring (2010) are looking for speakers for the following symposia (detailed descriptions and contact information are provided below). Please contact them ASAP if you are interested in speaking and if you have ideas for invited speakers.

#1. Sustainability in the Chemistry Curriculum: What, Why Now, and How
Cathy Middlecamp and Mary Kirchhoff, organizers

#2. Sustainability in the Chemistry Curriculum: Water for a Thirsty Planet
Karen Anderson and Jennifer Tripp, organizers

#3. Sustainability in the Chemistry Curriculum: Global Climate Change
Steve Keller and Anne Bentley, organizers

The organizers are seeking two types of speakers. One is people who have transformed courses in the curriculum and who can speak from experience. These folks can feel free to talk about the good, the bad, and the potholes. The other is people who can frame the issues and who can speak passionately and well about the topic. Organizers hope these folks will inspire others to start thinking about how they might change their curriculum. FYI, an ACS acquisitions editor is pushing to do a book on the series of talks.

OASYS will open mid-fall, closing before Thanksgiving.

Julie Haack, Ph.D.

Assistant Department Head and Senior Instructor

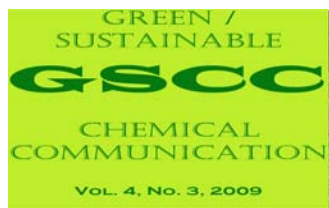
Department of Chemistry

1253 University of Oregon

Eugene, OR 97403-1253

Phone: (541) 346-4604

Fax: (541) 346-4643



綠色/永續
化學通訊

NEW BOOKS

Handbook of Green Chemistry - Green Solvents

By Paul T. Anastas (Series Editor), Walter Leitner (Editor), Philip G. Jessop (Editor), Chao-Jun Li (Editor), Peter Wasserscheid (Editor), Annegret Stark (Editor), Wiley (ISBN: 978-3-527-31574-1, Hardcover, 1300 pages, May 2010)

Green chemistry is the use of chemistry for pollution prevention. Edited by Yale's Director of the Center for Green Chemistry and Green Engineering, Paul T. Anastas, this landmark volume covers everything you need to know about this field, including feedstocks, green chemistry engineering, green catalysis (homogeneous, heterogeneous and biocatalysis), separations techniques, as well as solvents like supercritical fluids and ionic liquids. In addition to Prof. Anastas, who is the inventor of the famous 12 principles of green chemistry, each part is edited by an international expert. The essential one-stop reference for organic and environmental chemists, environmental agencies, and chemical engineers.



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Cover picture:

德國老城 Dresden 的夕陽---“夕陽無限好，只是近黃昏”。如何保有地球原始風貌、地物及景緻，捕捉剎那美感，是您我的責任。(abstract from YiChi Jao)。

Acknowledgments:

We are indebted to two experts Prof. Kwang-Ting Liu (劉廣定教授) and Prof. Lou-sing Kan (甘魯生教授) who sincerely wrote and collected the information at several stages for their helpful and invaluable suggestions on how to construct a practicable communication.

I also wish to gratefully acknowledge two photographers, YiChi Jao and Steven Zan, who provided us a series of pictures about the nature and green world taken from many countries in Europe.