TSCFA台灣超臨界流體協會
Taiwan Supercritical Fluid Association

電子報第 195 期

活動訊息

- ***論文徵稿***

  即日起徵求「能源與綠色製程」、「食品與生技醫藥」、「材料與精密製造」等3大主題領域的研究論文，邀請各界踴躍投稿，及蒞臨與會交流。

  https://www.tscfa.org.tw/ec99/rwd1480/news.asp?newsno=32

- ***ISASF 2023***

  日期：10月16-20日

  地點：水原市成均館大學(Sungkyunkwan University, Suwon)

產業新聞

- 亞果生醫再生醫學引領大健康產業

  資料來源：

  https://readers.ctee.com.tw/cm/20230607/a25ab1/1243628/share?fbclid=IwAR27bEnyN2Kv-Azmb6pjFFfAn0kU88ZVR6918ECMFdgY1Uiok5dxt9WWVqI

- 亞果逾 7 國 33 項醫材許可 動物組織再生人體新材料

  資料來源：https://news.gbimonthly.com/tw/audiovisual/show.php?num=60016

團體會員介紹

- 財團法人金屬工業研究發展中心

教育訓練班

- (夜間班)高壓氣體特定設備操作人員安全衛生教育訓練班 07/11~07/23
- (日間班)高壓氣體特定設備操作人員安全衛生教育訓練班 07/31~08/03

技術文摘

- Numerical investigation of subcritical and supercritical carbon dioxide fluidized beds using two fluid model and discrete element method 使用雙流體模型和離散元方法對亞臨界和超臨界二氧化碳流化床進行數值研究
- Numerical Investigations of Pseudo-Boiling and Multi-Component Mixing Under Trans-/supercritical Conditions for Engine Applications 發動機應用中跨/超臨界條件下偽沸騰和多組分混合的數值研究

- Removal of AAEMs from high alkali coal under supercritical CO_2 fluid-citric acid extraction system 超臨界 CO_2 流體-檸檬酸萃取系統去除高鹼煤中的 AAEMs
- Supercritical fluids behave as complex networks 超臨界流體之微結構與熱力性質關連的複雜網絡
- Supercritical-Assisted Ball-Milling Synthesis of Multicomponent $Si/Fe_3O_4/C$ Composites for Outstanding Lithium-Storage Capability 超臨界輔助球磨合成多組分 $Si/Fe_3O_4/C$ 複合材料具有出色的儲鋰能力
- The effects of sub/supercritical conditions on the spray interface characteristics of alkane fuel 亞/超臨界條件對烷烴燃料噴霧界面特性的影響
- The permeability of shale exposed to supercritical carbon dioxide 暴露於超臨界二氧化碳的頁岩滲透率

台灣超臨界流體協會
電話：(07)355-5706
E-mail：tscfa@mail.mirdc.org.tw

TSCFA 台灣超臨界流體協會

第二十二屆
超臨界流體技術應用與發展研討會

論文徵稿

發表日期｜2023年10月21日(六)

申請收件截止日期｜2023年9月15日(五)

審查結果通知日期｜2023年9月25日(一)

發表地點｜ 國立中興大學食品暨應用生物科技學系
食品生物科技大樓 演講廳 (台中市南區興大路145號)

論文主題

- 能源與綠色製程
- 食品與生技醫藥
- 材料與精密製造

聯絡資料：
台灣超臨界流體協會 吳家瑩小姐 專線：(07)355-5706 投稿信箱：tscfa@mail.mirdc.org.tw
協會網址：https://www.tscfa.org.tw

主辦單位｜國立中興大學食品暨應用生物科技學系 TSCFA 台灣超臨界流體協會

亞果生醫再生醫學引領大健康產業

工商時報 20230607．文 / 周榮發

興櫃生醫尖兵 - 亞果生醫 (6748) 十年磨一劍，去年底分別與博而美國際及久億生醫兩家大型通路商簽訂複數年醫材供應合約，該供應合約計劃從今 (2023) 年開始逐步增溫出貨，適巧搭上該公司規劃於今年第三季正式遞件申請上櫃，將帶給社會投資大眾滿滿想像空間。

該公司執行長謝達仁博士表示，生醫產業市場磨合期很久，要不斷研發、不斷取證、不斷臨床試驗，即使一切數據合乎預期，仍要有適當的時機點才能一擊即中。亞果生醫歷經重重淬鍊，期間，獲得眾多的研發成果，也將成果分享在國際生醫產業，終致獲得數家知名法人投資參與，而股東及法人看到的是再生醫學的未來性及產生的經濟規模，21 世紀的再生醫學將是全球生醫產業追求的顯學。

如今，亞果生醫所推動的再生醫學正逐步迎來喜訊，除大型醫材通路商積極尋求合作外，亞果生醫獨步全球的生醫技術「去細胞器官及其製備方法」也正式取得歐洲專利核准，這代表亞果生醫最早與澳大利亞 Oculus Biomed Pty Ltd(OBM) 生醫公司、日本丸紅商社及美國 NASA 太空總署的策略合作，正式跨足到歐盟國家了。

謝達仁緊接著強調，亞果生醫聲名遠播，在國際間執醫材通路牛耳的瑞士商 DKSH，看好亞果生醫的生物醫材，特別是骨填料及敷料，正洽談越南的總代理權；而另一項重大的國際合作案，是已數次接觸會談的新加坡生技集團，該集團經營團隊日前到南科高雄科學園區亞果生醫公司進行深度拜訪，除洽談眼角膜、醫學美容毛髮增生及皺紋填補整型植入劑授權大陸市場使用權外，更提及中長期策略投資及合作設立生醫材料廠。從目前諸多策略合作案來看，亞果生醫這艘裝滿技術與希望的大船正欲揚帆，航向人類的大健康與生命的美好。

資料來源：
https://readers.ctee.com.tw/cm/20230607/a25ab1/1243628/share?fbclid=IwAR27bEnyN2Kv-Azmb6pjFFfAn0kU88ZVR6918ECMFdgY1Uiok5dxt9WWVqI

亞果逾 7 國 33 項醫材許可 動物組織再生人體新材料

2023-06-27

亞果生醫股份有限公司設立於2014年6月，**主要以研發生產人體組織器官再生修護材料，亞果擁有自主開發之平台技術『超臨界二氧化碳流體去細胞技術』**，可以將動物組織器官中的過敏原，包括脂肪、細胞以及游離蛋白雜質完全清除掉，同時保留完整的膠原蛋白支架結構(Collagen scaffolds)，**做為人體組織器官修護材料，可望取代人體捐贈的各種組織器官**，且來源充沛取得容易。

亞果透過從豬隻衍生的組織工程材料包括人工皮膚、骨粉、骨塊、軟骨、眼角膜、動脈血管、周邊神經及脊柱神經、氣管、輸尿管、心臟、腎臟、肝臟等，解決過去從病人身上挖東牆補西牆的手術方式，或是漫長的等待捐贈器官的椎心之痛。

轉上櫃增資 續攻國際市場

截至2023年3月底止，亞果已經取得48個國內外發明專利，還有20幾個審查中的專利。

從第一個高階醫療器材在2017年5月取得美國FDA510k銷售許可至今，**亞果已經取得3項產品的美國FDA510k，4項一類醫材美國FDA自我宣告；10項產品台灣衛福部TFDA二類醫材銷售許可證書，4項產品台灣衛福部TFDA一類醫材銷售許可證書；**2項產品新加坡HAS class D 醫材許可；4項產品菲律賓PFDA class D 醫材許可；2項產品越南class D 醫材許可；3項產品泰國class D 醫材許可；1項產品印度class D 醫材許可。

為了讓亞果生醫快速進軍國際市場，亞果也將規劃進入資本市場讓公司財務公開透明，成為公開上櫃的公司，以增加國際合作夥伴的信心，同時也規劃轉上櫃前現金增資引進策略投資人，協助公司更健全的發展，也期盼透過參與本次BIO Asia-Taiwan，推廣公司技術、尋求國內外潛在經銷通路以及項目開發合作夥伴。

資料來源：https://news.gbimonthly.com/tw/audiovisual/show.php?num=60016

財團法人金屬工業研究發展中心
Industrial Technology Research Insititute

願景與使命

成為以金屬科技領航及跨領域創造產業價值的國際級研究發展機構

中心簡介

金屬中心的設立：

民國五十二年十月，我國政府與聯合國特別基金會及國際勞工局會同訂立「金屬工業發展計畫」於高雄市成立財團法人金屬工業發展中心。五年後該計畫圓滿完成，乃於五十七年十月移交給我政府繼續運作，以促進我國金屬工業之成長與發展。本中心為加強研發技術，特於八十二年五月起，更名為金屬工業研究發展中心

金屬中心的主要任務：

金屬工業研究發展中心為非營利性財團法人，從事金屬及其相關工業所需生產與管理技術之研究發展與推廣。旨在促進國內金屬及其相關工業升級，使其具備國際市場良好之競爭能力。

政策方針

未來重點方向

- 金屬中心近年來因應國內經濟環境變化快速，以整體產業需求為考量，聚焦重點產業，設定產業目標與發展策略。**透過組織變革及技術研發方向的調整，已逐步調整組織架構，著重於跨部門之整合、企劃力**，以符合產業的需求與外界的挑戰。
- 成立人力資源發展委員會，建立人才培訓與人力編裝之機制，**強化博士人員晉用比例**，並與**國際產學研研究機構進行單位間長期國際合作，建立機構間合作互補分工模式。**
- 透過科專企劃管考功能，加強系統化、整合性業務推動，**強化技術商品化、智財權應用、整合行銷服務等技術加值及推廣工作**。相信中心有能量可以為國內產業做更好的服務，以帶動產業創新，創造產業價值。

資料來源：https://www.mirdc.org.tw/index.aspx

NPiL 天然物創新應用研究所

Natural Products innovation Laboratories

財團法人金屬工業研究發展中心

◘ 技術服務項目：

◆超臨界CO_2萃取、分離、純化技術
◆天然物機能性成分提取與高值化應用
◆晶球、微膠囊與滴丸劑型開發技術
◆酒精/水萃取濃縮技術
◆液化冷媒精油萃取技術
◆粉碎/研磨與低溫乾燥技術
◆發酵製程與設備開發技術
◆超高壓水處理技術
◆化妝/保健食品商品化開發技術
◆測試、試量產放大試驗
◆製程檢測分析技術
◆軟性食品晶球製程及設備技術

◘ 量產工廠規劃：

◆超臨界CO_2萃取設備
◆超臨界CO_2分餾設備
◆超臨界CO_2層析設備
◆天然物萃取/分離/純化/功效驗證/劑型/包裝設計等生產設備與產線開發

◘ 技術應用領域：

天然物或中草藥中機能性有效成分之萃取與純化、精油精製、無縫膠囊、滴丸等高值化應用。

◆產業應用廣泛

生技、食品、中草藥、化妝品、保健食品與精緻化農/漁/牧業等。

◆傳產升級轉型

發展天然高值化機能性食品、中草藥美容美妝產品，標榜以台灣栽種、養殖、培育的有機/無毒品質控管、低溫萃取純化之MIT特色產品。

超臨界CO_2萃取設備

超臨界CO_2分餾設備

超高壓水設備

軟性食品晶球製程及設備技術

酒/水萃取濃縮設備

◘ NPiL研發可技轉高值化產品：

牛樟芝滴丸

金銀花保養品禮盒

檜木精油禮盒

90度醇高粱

精萃黃金芝麻油

滴丸禮盒

天然物創新應用研究所
嘉義市西區60060博愛路二段569號 http://www.npil.org.tw Tel:05-2918866

Professional Supercritical Fluid Engineering

■ Food & Pharmaceuticals

- —$SCCO_2$ extraction, fractionation, chromatography
- —Liquid/supercritical CO_2 degreasing
- —Supercritical micro-powder forming system
- —R134a extraction system for essential oils(*New*)

20Lx2x40MPa $SCCO_2$ Extraction System

■ Surface Treatment

- —$SCCO_2$ cleaning, drying, plating
- —Supercritical fluid surface modification(*New*)

■ Energy & Chemical Engineering

- —SCMeOH for biodiesel production
- —Hydrothermal liquefaction of wet bio-Wastes(*New*)
- —Supercritical hydrogenation reaction(*New*)
- —Subcritical propane extraction for microalgae oil(*New*)

$SCCO_2$ Powder Forming Sys.

2LPHx35MPa $SCCO_2$ Fractionation System

2Lx70MPa $SCCO_2$ Extraction Sys.

25MPa/480°C Supercritical Fluid Tubular reactor System

Subcritical Water Biomass Treatment System (24MPa/350°C, 100L)

■ Instruments

- —High pressure tester(water: 160MPa; nitrogen: 100MPa)
- —High Pressure water platform(600MPa, 1L、10L autoclaves)

■ Industrial Service

- —Supercritical Fluid & High Pressure Processing Systems for healthy foods, essential oils, cosmetics, medicines, food processing, etc.
- —High Pressure & High Temperature for hydrothermal reactions, hydrolysis, pyrolysis, synthesis reactions, etc.

Bio-process & Energy Engineering Section, MIRDC
web: www.mirdc.org.tw

TSCFA 台灣超臨界流體協會
Taiwan Supercritical Fluid Association

(夜間班)高壓氣體特定設備操作人員安全衛生教育訓練班

需要有操作證照的單位，歡迎向協會報名。

●上課日期：**(夜班)07/11~07/20 18:30~21:30；07/22~07/23 08:00~17:00(實習)**

●上課時數：高壓氣體特定設備操作人員安全衛生教育訓練課程時數 35 小時＋2 小時(測驗)。

●課程內容：高壓氣體概論 3HR、種類及構造 3HR、附屬裝置及附屬品 3HR、自動檢查與檢點維護 3HR、安全裝置及其使用 3HR、操作要領與異常處理 3HR、事故預防與處置 3HR、安全運轉實習 12HR、高壓氣體特定設備相關法規 2HR，共 35 小時。(另加學科測驗 1 小時及術科測驗約 1~2 小時)

●上課地點：高雄市楠梓區高楠公路 1001 號【金屬工業研究發展中心研發大樓 2 樓　產業人力發展組】

●參加對象：從事高壓氣體特定設備操作人員或主管人員。

●費　　用：本班研習費**新台幣 7,000 元整**，**本會會員享九折優惠**。

●名　　額：每班 30 名，額滿為止。

●結訓資格：期滿經測驗成績合格者，取得【高壓氣體特定設備操作人員安全衛生訓練】之證書。

●報名辦法：1.傳真報名：(07)355-7586台灣超臨界流體協會
2.報名信箱：tscfa@mail.mirdc.org.tw
3.研習費請電匯至 兆豐國際商銀 港都分行(代碼017)
戶名：社團法人台灣超臨界流體協會 帳號：002-09-018479（註明參加班別及服務單位）或以劃線支票抬頭寫「台灣超臨界流體協會」連同報名表掛號郵寄台灣超臨界流體協會，本會於收款後立即開收據寄回。

※洽詢電話：(07)355-5706 吳小姐繳交一吋相片一張及身份證正本

報　　名　　表

課程名稱	高壓氣體特定設備操作人員安全衛生教育訓練			上課日期	112 年 7/11~7/23	
姓　　名	出生年月日	身份證字號	手機號碼	畢業校名		公司產品
服務單位				電　　話		
服務地址	□□□			傳　　真		
發票住址	□□□			統一編號		
負 責 人	人	訓練聯絡人 / 職稱		email：		
參加費用	共　　元	參加性質		□公司指派　　□自行參加		
繳費方式	□郵政劃撥　□支票　□附送現金			報名日期	年　　月　　日	

※ 出生年月日、身份證字號、畢業校名、電話、地址須詳填，以利製作證書。〔！〕

上課日期時間表

課程名稱：(日間班)高壓氣體特定設備操作人員安全衛生教育訓練班

2023/07/11 (二)	18:30 ~ 21:30
2023/07/12 (三)	18:30 ~ 21:30
2023/07/13 (四)	18:30 ~ 21:30
2023/07/14 (五)	18:30 ~ 21:30
2023/07/17 (一)	18:30 ~ 21:30
2023/07/18 (二)	18:30 ~ 21:30
2023/07/19 (三)	18:30 ~ 21:30
2023/07/20 (四)	18:30 ~ 21:30
2023/07/22 (六)	08:00 ~ 17:00 (實習第 1 組)
2023/07/23 (日)	08:00 ~ 14:00 (實習第 1 組)

TSCFA台灣超臨界流體協會
Taiwan Supercritical Fluid Association

(日間班)高壓氣體特定設備操作人員安全衛生教育訓練班

需要有操作證照的單位，歡迎向協會報名。

●上課日期：**07/31~08/02 08:00~17:00**；**08/03~08/03 08:00~17:00(實習)**

●上課時數：高壓氣體特定設備操作人員安全衛生教育訓練課程時數 35 小時＋2 小時(測驗)。

●課程內容：高壓氣體概論 3HR、種類及構造 3HR、附屬裝置及附屬品 3HR、自動檢查與檢點維護 3HR、安全裝置及其使用 3HR、操作要領與異常處理 3HR、事故預防與處置 3HR、安全運轉實習 12HR、高壓氣體特定設備相關法規 2HR，共 35 小時。(另加學科測驗 1 小時及術科測驗約 1~2 小時)

●上課地點：高雄市楠梓區高楠公路 1001 號【金屬工業研究發展中心研發大樓 2 樓　產業人力發展組】

●參加對象：從事高壓氣體特定設備操作人員或主管人員。

●費　　用：本班研習費**新台幣 7,000 元整**，**本會會員享九折優惠**。

●名　　額：每班 30 名，額滿為止。

●結訓資格：期滿經測驗成績合格者，取得【高壓氣體特定設備操作人員安全衛生訓練】之證書。

●報名辦法：1.傳真報名：(07)355-7586台灣超臨界流體協會
2.報名信箱：tscfa@mail.mirdc.org.tw
3.研習費請電匯至 兆豐國際商銀 港都分行(代碼017)
戶名：社團法人台灣超臨界流體協會 帳號：002-09-018479（註明參加班別及服務單位）或以劃線支票抬頭寫「台灣超臨界流體協會」連同報名表掛號郵寄台灣超臨界流體協會，本會於收款後立即開收據寄回。

※洽詢電話：(07)355-5706 吳小姐繳交一吋相片一張及身份證正本

報　　名　　表

課程名稱	高壓氣體特定設備操作人員安全衛生教育訓練			上課日期	112 年 07/31~08/03	
姓　　名	出生年月日	身份證字號	手機號碼	畢業校名		公司產品
服務單位				電　　話		
服務地址	□□□			傳　　真		
發票住址	□□□			統一編號		
負 責 人	人	訓練聯絡人 / 職稱		email：		
參加費用	共　　元	參加性質		□公司指派　　□自行參加		
繳費方式	□郵政劃撥　□支票　□附送現金			報名日期	年　　月　　日	

※ 出生年月日、身份證字號、畢業校名、電話、地址須詳填，以利製作證書。〔！〕

上課日期時間表

課程名稱：(日間班)高壓氣體特定設備操作人員安全衛生教育訓練班

2023/07/31 (一)	08:00 ~ 17:00
2023/08/01 (二)	08:00 ~ 17:00
2023/08/02 (三)	08:00 ~ 17:00
2023/08/03 (四)	08:00 ~ 17:00 (實習第 1 組)

Numerical investigation of subcritical and supercritical carbon dioxide fluidized beds using two fluid model and discrete element method

使用雙流體模型和離散元方法對亞臨界和超臨界二氧化碳流化床進行數值研究

By **Wenjian Cai[a], Xietian Xia[b], Xiang Li[b], Xing Chen[b], Zenghui Xu[b], Guodong Liu[a]**

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[b] China Construction Eco-Environment Protection Technology Co. Ltd, Suzhou, China

Abstract

Fluidization state of ambient, subcritical and supercritical carbon dioxide (CO_2) fluid fluidized beds are simulated using Computational Fluid Dynamics-Discrete Element Method (CFD-DEM) and Two-Fluid Model (TFM) combined with Low Density Ratio-Kinetic Theory of Granular Flow (LDR-KTGF). Quantitative and qualitative analysis were executed between TFM and CFD-DEM simulation results. Fluidization process using two methods coincides with predictions of stability function and different criteria for distinguishing from particulate and aggregative fluidizations. A transitional fluidization with the wave-like and chunk-like flows occurs in subcritical CO_2 fluid fluidized bed, and the bubble-like and particle aggregative-like flows are observed in ambient and supercritical states, respectively. The discrepancies in volume fractions and velocities obtained using TFM and CFD-DEM approaches were small, while the predicted turbulent kinetic parameters and bubble-like kinetic energy show sensitivity to the turbulence model. Statistical analysis of the turbulent normal Reynolds stresses indicated an anisotropic flow of particles.

資料來源：https://doi.org/10.1016/j.supflu.2023.105942

Numerical Investigations of Pseudo-Boiling and Multi-Component Mixing Under Trans-/supercritical Conditions for Engine Applications

發動機應用中跨/超臨界條件下偽沸騰和多組分混合的數值研究

By **Jie Ma, Hongsheng Liu, Liang Li & Maozhao Xie**

Key Laboratory of Ocean Energy Utilization and Energy Conservation of Ministry of Education, Dalian University of Technology, Dalian, PR China

Abstract

The fuel injection and mixing process are often carried out under trans-/supercritical conditions for engine applications; however, the process is still unclear. In this study, based on OpenFOAM, a multi-component trans-/supercritical spray model based on the KT/KNP scheme is developed, which covers the special real fluid equation of state, various mixing rules and modified thermodynamic properties. In addition, the PIMPLE algorithm is extended to deal with the high nonlinearity. First, a one-dimensional advection case is applied to evaluate the performance of the model. Then, the effect of various mixing rules and pseudo-boiling phenomenon on n-heptane/nitrogen jet are thoroughly analyzed under trans-/supercritical conditions. The results show that the jet is extremely sensitive to the changes of the initial jet temperature and chamber pressure, and the “heat shield” effect of pseudo-boiling delays the breakup and mixing in the transcritical jet. With the mixing of different components, unlike the single-component condition, the pseudo-boiling intensity will increase. The increase of pressure and occurrence of mixing will lead to the decrease of pseudo-boiling temperature, and the pseudo-boiling will end earlier, which is obviously different from the single-component fluid case. For the n-heptane/nitrogen mixture, when the mole fraction of n-heptane in the mixture changes from 1.0 to 0.7, and the pseudo-boiling temperature decreases from 571 K to 465 K. With increasing injection temperature or chamber pressure, the pseudo-boiling intensity gradually decreases, and the potential core shortens, the difference among various mixing rules decreases. When the injection temperature is higher than 571 K, the pseudo-boiling phenomenon no longer exists. When the chamber pressure reaches 9 MPa, the pseudo-boiling strength is very low. Therefore, the spray mixing under supercritical conditions will be more sufficient. With the occurrence of mixing, the critical parameter gradually transitions from the critical value of n-heptane to the critical value of nitrogen, which strongly depends on the mixing rule.

Keywords: Trans-/supercritical conditions, pseudo-boiling, dense-fluid method, multi-component thermodynamic properties

資料來源：https://doi.org/10.1080/00102202.2023.2214947

Removal of AAEMs from high alkali coal under supercritical CO_2 fluid-citric acid extraction system

超臨界 CO_2 流體-檸檬酸萃取系統去除高鹼煤中的 AAEMs

By **Junwei Guo, Mingrui Zhang, Guanghui Yan, Zhenxing Zhang, Pengfei Zhao, Mengyao Guo & Bo Zhang**

[a] Key Laboratory of Coal Processing and Efficient Utilization of Ministry of Education, China University of Mining & Technology, Xuzhou, Jiangsu, China

[b] School of Chemical Engineering & Technology, China University of Mining & Technology, Xuzhou, China

Abstract

In this paper, a method for dealkalization and upgrading of high alkali coal by supercritical CO_2 fluid-citric acid extraction system is proposed. The leaching mechanism was explored by microstructural changes of elements and functional groups in coal samples, and single-factor optimization experiment was conducted. The result shows that supercritical CO_2 fluid-citric acid extraction can effectively remove alkali and alkaline earth metals. The extraction mechanism is the reaction of H^+ with inorganic minerals and the ion exchange of H^+ with the form of phenolic hydroxyl and carboxyl groups. Under the optimum conditions, the removal rates of Ca and Mg are 44.95% and 65.75% respectively. The ash content of coal is 2.42%, and the content of Na_2O (calculated by ash) is 1.13%, which meet the standards of power coal in China. Supercritical CO_2 fluid-citric acid extraction is an effective and promising method for the cleaning of high alkali coal.

Keywords: Supercritical CO_2 fluid, citric acid, extraction, mechanism, high alkali coal

資料來源：https://doi.org/10.1080/15567036.2023.2211039

Supercritical fluids behave as complex networks

超臨界流體之微結構與熱力性質關連的複雜網絡

By Filip Simeski & Matthias Ihme

Department of Mechanical Engineering, Stanford University, Stanford, CA, 94305, USA

Department of Photon Science, SLAC National Accelerator Laboratory, Menlo Park, CA, 94025, USA

Abstract

Supercritical fluids play a key role in environmental, geological, and celestial processes, and are of great importance to many scientific and engineering applications. They exhibit strong variations in thermodynamic response functions, which has been hypothesized to stem from the microstructural behavior. However, a direct connection between thermodynamic conditions and the microstructural behavior, as described by molecular clusters, remains an outstanding issue. By utilizing a first-principles-based criterion and self-similarity analysis, we identify energetically localized molecular clusters whose size distribution and connectivity exhibit self-similarity in the extended supercritical phase space. We show that the structural response of these clusters follows a complex network behavior whose dynamics arises from the energetics of isotropic molecular interactions. Furthermore, we demonstrate that a hidden variable network model can accurately describe the structural and dynamical response of supercritical fluids. These results highlight the need for constitutive models and provide a basis to relate the fluid microstructure to thermodynamic response functions.

資料來源：https://www.nature.com/articles/s41467-023-37645-z

Supercritical-Assisted Ball-Milling Synthesis of Multicomponent Si/Fe_3O_4/C Composites for Outstanding Lithium-Storage Capability

超臨界輔助球磨合成多組分 Si/Fe_3O_4/C 複合材料具有出色的儲鋰能力

By **Liuyi Hu, Zhihang Lu, Fei Chen, Jun Zhang, Yang Xia, Wenkui Zhang*, Yongping Gan, Xinping He, Wenlong Song, and Hui Huang***

College of Materials Science and Engineering, Zhejiang University of Technology, Hangzhou 310014, People's Republic of China

Abstract

Attributed to high theoretical capacity and abundant reserves, Si/C anodes have been commercialized in lithium-ion batteries (LIBs). However, the shortcomings of poor interfacial compatibility, low rate performance, and bad stability remain to be overcome. In this paper, a facile method for the synthesis of silicon/iron oxide/carbon (Si/Fe3O4/C) composites by ball-milling in a supercritical carbon dioxide (scCO2) fluid medium is proposed. This method utilizes the diffusion characteristics, extremely low viscosity, and excellent mass transfer properties of supercritical fluids. Under the infiltration of an scCO2 fluid, mesophase carbon microspheres (MCMB) are exfoliated into graphite flakes and achieve good interfacial fusion with silicon and Prussian blue during ball-milling. The Prussian blue is transformed into Fe3O4 by subsequent heat treatment under a nitrogen atmosphere, and Fe3O4 introduced in this way enhances the lithium-storage capacity, cycling stability, and rate performance significantly of Si/C anodes. As an anode for LIBs, the reversible capacity of Si/Fe3O4/C reaches 1363 mA h g–1 after 600 cycles at 1 A g–1. This study provides an idea for the design and fabrication of Si-based anode materials with high capacity and long cycle life.

資料來源：https://doi.org/10.1021/acs.energyfuels.3c01074

The effects of sub/supercritical conditions on the spray interface characteristics of alkane fuel

亞/超臨界條件對烷烴燃料噴霧界面特性的影響

By **Ruina Li, Yang Song, Liang Zhang, Yikai Qian, Zhong Wang, Yiqiang Pei & Yanzhao An**

State key laboratory of engines (Tianjin university), Tianjin university, Tianjin, China

Abstract

Alkane fuels are widely used in engines. The spray characteristics in supercritical environments are very different than in subcritical environments, and supercritical environments significantly impact the formation of the gas mixture in the engine. In this paper, the spray images of n-heptane and n-tetradecane in subcritical (500K-2MPa) and supercritical (700K-4MPa, 800K-6MPa) environments were obtained on the constant volume spray test platform. The effects of the supercritical environment and carbon chain length of alkane fuel on spray characteristic parameters were investigated. The results showed that the carbon chain length and ambient pressure are the main factors of penetration. The ambient pressure is the main factor of the spray cone angle and the spray non-liquid layer thickness. Compared with n-heptane, in the 500K-2MPa (subcritical) environment, the cone angle of n-tetradecane was reduced by 2°, the penetration was increased by 10 mm, and the spray non-liquid layer thickness was reduced by about 1 mm. In the 800K-6MPa (supercritical) environment, the cone angle of n-tetradecane was increased by 2°, the penetration was increased by 10 mm, and the spray non-liquid layer thickness was increased by about 1.2 mm. In addition, the calculation model of alkane fuel spray penetration in sub/supercritical environments was modified and achieved 95% prediction accuracy.

Keywords: Heptane, Tetradecane, Supercritical, Spray characteristics, Constant volume combustion bomb

資料來源：https://doi.org/10.1080/15567036.2023.2214101

The permeability of shale exposed to supercritical carbon dioxide

暴露於超臨界二氧化碳的頁岩滲透率

By Di Wu, Wenbo Zhai, Xueying Liu, Xiaochun Xiao, Jun Xu, Nan Jia & Feng Miao

School of Mechanics and Engineering, Liaoning Technical University, Fuxin, Liaoning, 123000, China

Abstract

Permeability is a critical parameter of tight reservoir rocks and one of the important parameters for characterizing fluid flow and production from reservoirs. It determines the feasibility of its commercial development. SC-CO_2 has been used in shale gas exploitation for efficient fracturing and the added benefit of CO_2 geo-storage. And SC-CO_2 plays an important role in permeability evolution of shale gas reservoirs. In this paper, Firstly, the permeability characteristics of shale under CO_2 injection are discussed. The experimental results show that the relationship between permeability and gas pressure is not a single exponential relationship, but there is an obvious segmentation phenomenon, which is particularly obvious when it is close to the supercritical state, and the overall trend is first decreased and then increased. Subsequently, other specimens were selected for SC-CO_2 immersion, and nitrogen was used to calibrate and compare shale permeability before and after treatment to assess changes in shale permeability after SC-CO_2 treatment at pressures from 7.5 to 11.5 MPa and X-ray diffraction (XRD) analysis and scanning electron microscopy (SEM) were used to analyze the raw and CO_2-treated shale particle sample, respectively. Results indicate the permeability increases significantly after SC-CO_2 treated, and permeability growth is a linear function of SC-CO_2 pressure. According to (XRD) analysis and (SEM) analysis, SC-CO_2 not only can act as a solvent and dissolve carbonate minerals and clay minerals, but also can complex chemical reactions with mineral components in shale, Further dissolution of carbonate minerals and clay minerals, widened gas seepage channels and enhancing the permeability.

資料來源：https://www.nature.com/articles/s41598-023-33702-1