

Wu, Nae-Lih (吳乃立)

Professor

B.S. in Chemical Engineering
National Taiwan University, 1980
Ph.D. in Chemical Engineering
Pennsylvania State University, 1987

Research and Professional Interests
Materials processing and characterization
Materials for Electrochemical Energy
Storage (Li-ion batteries, Supercapacitors)

Projects (started from 2013)

1. Research on Cathode of Li-S Battery and Solid-Electrolyte (2/3)
鋰硫電池硫正極與固態電解質的研發 (2/3)
Sponsored by National Science Council
NT\$1,590,000; 2013/8/1-2014/7/31
2. Joint research on process scale-up and performance upgrading of Li(1+x)(Ni,Mn)O₂ cathode for Li-ion batteries
鋰離子電池大容量富鋰鎳錳正極粉體的製程放大與性能提升計畫(2/2)
Sponsored by National Science Council
NT\$5,200,000; 2013/12/1-2014/11/30
3. Research on Metal-Si Composites of High-Tap Density for Li-ion Batteries (I)
鋰離子電池高振實密度金屬/矽複合負極材料之開發 (一)
Sponsored by National Science Council
NT\$800,000; 2013/1/1-2013/12/31
4. Noncrystalline Carbon Anode for Electric Vehicle Applications (II)
電動車用鋰電池之非晶型碳材開發-鋰離子電池非晶型負極碳材性能提升(II)
Sponsored by CPC Coporation, Taiwan
NT\$800,000; 2013/8/1-2014/7/31

Journal Papers

1. Yu-Chan Yen, Sung-Chieh Chao, Hung-Chun Wu, and **Nae-Lih Wu**, "Study on Solid-Electrolyte-Interphase of Si and C-coated Si anodes," *J. Electrochem. Soc.*, 156, A95-102 (2009) (SCI, EI).
2. Kuang-Tsin Lee, Jyh-Fu Lee, and **Nae-Lih Wu**, "Electrochemical Characterizations on MnO₂ Supercapacitors with Potassium Polyacrylate and Potassium Polyacrylate-co-Polyacrylamide Gel Polymer Electrolytes," *Electrochimica Acta* 54, 6148-6153 (2009). (SCI, EI)
3. Wei-Ren Liu, Yu-Chan Yen, Hung-Chun Wu, Mo-Hua Yang, Martin Winter, and **Nae-Lih Wu**, "Nano-porous SiO/Carbon Composite Anode for Lithium-Ion Batteries," *J. Appl. Electrochem.*, 39, 1643 (2009). (SCI, EI)
4. Hsien-Chang Wu, Yen-Po Lin, Eric Lee, Wen-Ting Lin, Jui-Kai Hu, Hung-Chang Chen, and **Nae-Lih Wu**, "High-performance Carbon-based Supercapacitors Using Al Current

- Collector with Conformal Carbon Coating,” *Materials Chemistry and Physics*, 117 (2009) 294–300. (SCI, EI)
5. Yen-Po Lin and **Nae-Lih Wu**^{*}, “Characterization of MnFe₂O₄/LiMn₂O₄ Aqueous Asymmetric Supercapacitor,” *J. Power Sources* 196 (2011) 851–854. (SCI, EI)
 6. Chih-Yi Chang and **Nae-Lih Wu**^{*}, “Process Analysis on Photocatalyzed Dye-Decomposition for Water Treatment with TiO₂-coated Rotating Disk,” *Industrial & Engineering Chemistry Research* 49 (2010) 12173–12179. (SCI, EI)
 7. F. Ataherian, K. T. Lee and **Nae-Lih Wu**^{*}, “Long-Term Electrochemical Behaviors of Manganese Oxide Aqueous Electrochemical Capacitor under Reducing Potentials,” *Electrochimica Acta* 55 (2010) 7429–7435. (SCI, EI)
 8. Kuang-Tsin Lee, Chung-Bo Tsai, Wen-Hsien Ho, and **Nae-Lih Wu**^{*}, “Superabsorbent Polymer Binder for Achieving MnO₂ Supercapacitors of Greatly Enhanced Capacitance Density,” *Electrochem. Commun.* 12 (2010) 886–889. (SCI, EI)
 9. Hsien-Chang Wu, Hung-Chun Wu, Eric Lee, **Nae-Lih Wu**^{*}, “High-temperature carbon-coated aluminum current collector for enhanced power performance of LiFePO₄ electrode of Li-ion batteries,” *Electrochem. Commun.* 12, 488–491 (2010). (SCI, EI)
 10. Sung-Chieh Chao, Yu-Chan Yen, Yen-Fang Song, Yi-Ming Chen, Hung-Chun Wu, and **Nae-Lih Wu**^{*}, “A Study on the Interior Microstructures of Working Sn Particle Electrode of Li-Ion Batteries by In-situ X-Ray Transmission Microscopy,” *Electrochem. Commun.* 12, 234–237 (2010). (SCI, EI)
 11. Sung-Chieh Chao, Yen-Fang Song, Chun-Chieh Wang, Hwo-Shuenn Sheu, Hung-Chun Wu, and **Nae-Lih Wu**^{*}, “Study on Microstructural Deformation of Working Sn and SnSb Anode Particles for Li-ion Batteries by In-Situ Transmission X-Ray Microscopy,” *J. Phys. Chem. C*, 115, 22040–22047 (2011). (SCI, EI)
 12. Sung-Chieh Chao, Yu-Chan Yen, Yen-Fang Song, Hwo-Shuenn Sheu, Hung-Chun Wu, and **Nae-Lih Wu**^{*}, “In Situ Transmission X-ray Microscopy Study on Working SnO Anode Particle of Li-ion Batteries,” *J. Electrochem. Soc.* 158, A1335–1339 (2011). (SCI, EI)
 13. F. Ataherian and **Nae-Lih Wu**^{*}, “1.2 Volt Manganese Oxide Symmetric Supercapacitor,” *Electrochem. Commun.* 13, 1264–1267 (2011). (SCI, EI)
 14. R.Subadevi, M.Sivakumar, S.Rajendran, H.-C.Wu, **Nae-Lih Wu**, “Development and Characterizations of PVdF-PEMA gel polymer electrolytes,” *Ionics*, in press (2011). (SCI, EI)
 15. Yen-Po Lin, Chung-Bo Tsai, Wen-Hsien Ho, and **Nae-Lih Wu**^{*}, “Comparative Study on Nanostructured MnO₂/Carbon Composites Synthesized by Spontaneous Reduction for Supercapacitor Application,” *Mater. Chem. Phys.*, 130 (2011) 367– 372. (SCI, EI)
 16. F. Ataherian and **Nae-Lih Wu**^{*}, “Long-Term Charge/Discharge Cycling Stability of MnO₂ Aqueous Supercapacitor under Positive Polarization,” *J. Electrochem. Soc.* 158 (2011) A422–A427. (SCI, EI)
 17. R. Subadevi, M. Sivakumar, S. Rajendran, H.-C. Wu, **N.-L. Wu**, “Studies on the Effect of Anions of Various LithiumSalts in PEMA Gel Polymer Electrolytes,” *Journal of Applied Polymer Science* 119 (2011) 1–6. (SCI, EI)
 18. Yen-Po Lin and **Nae-Lih Wu**^{*}, “Characterization of MnFe₂O₄/LiMn₂O₄ Aqueous Asymmetric Supercapacitor,” *J. Power Sources* 196 (2011) 851–854. (SCI, EI)
 19. Hsien-Chang Wu, Eric Lee, **Nae-Lih Wu**^{*}, and T. Richard Jow, “Effects of Current

- Collectors on Power Performance of Li₄Ti₅O₁₂ Anode for Li-Ion Battery,” *J. Power Sources* 197, 301-304 (2012). (SCI, EI)
20. Chun-Chieh Lin, Yu-Chan Yen, Hung-Chun Wu and **Nae-Lih Wu**^{*}, “Synthesis of porous Si particles by metal-assisted chemical etching for Li-ion battery application,” *J. Chin. Chem. Soc.* 59, 1226-1232 (2012). (SCI, EI)
 21. O. Ghodbane, F. Ataherian, **Nae-Lih Wu** and Frédéric Favier^{*}, “In situ crystallographic investigations of charge storage mechanisms in MnO₂-based electrochemical capacitors,” *J. Power Sources*, 206, 454–462 (2012). (SCI, EI)
 22. Ho-Seong Nam, **Nae-Lih Wu**, Kuang-Tsin Lee, Kwang Man Kim, Chul Gi Yeom, Lovely Rose Hepowit, Jang Myoun Ko^{*}, and Jong-Duk Kim, “Electrochemical Capacitances of a Nanowire-Structured MnO₂ in Polyacrylate-Based Gel Electrolytes,” *J. Electrochem. Soc.*, 159 A899-A903 (2012). (SCI, EI)
 23. R. Subadevi, M.Sivakumar^{*}, S.Rajendran, H.-C.Wu, **Nae-Lih Wu**, “Development and Characterizations of PVdF-PEMA gel polymer electrolytes,” *Ionics*, 18, 283-289 (2012). (SCI, EI)
 24. Sook-Keng Chang, K. T. Lee, Z. Zainal^{*}, K. B. Tan, N. A. Yusof, W. M. Daud, W. Yusoff, J. F. Lee and **Nae-Lih Wu**^{*}, “Structural and Electrochemical Properties of Manganese Substituted Nickel Cobaltite for Supercapacitor Application,” *Electrochimica Acta* 67, 67-72 (2012). (SCI, EI)
 25. C. N. Lin, C. Y. Chang, H. J. Huang, D. P. Tsai, and **Nae-Lih Wu**^{*}, “Photocatalytic Degradation of Methyl Orange by a Multi-Layer Rotating Disk Reactor,” *Environ Sci Pollut Res*, 19, 3743–3750 (2012).
 26. Jui-Pin Yen, Chien-Ming Lee, Tsung-Lung Wu, Hung-Chun Wu, Ching-Yi Su, **Nae-Lih Wu**, and Jin-Long Hong^{*}, “Enhanced High-Temperature Cycle-Life of Mesophase Graphite Anode with Styrene–Butadiene Rubber/ Carboxymethyl Cellulose Binder,” *ECS Electrochem. Lett.*, 1, A80-82 (2012).
 27. Yu-Ting Weng, Chung-Bo Tsai, Wen-Hsien Ho, **Nae-Lih Wu**^{*}, “Polypyrrole/carbon supercapacitor electrode with remarkably enhanced high-temperature cycling stability by TiC nanoparticle inclusion,” *Electrochem. Commun.* 27, 172-175 (2013). (SCI, EI)
 28. Shih-Min Chang, Erwin F. Rodriguez Tolaya, Yao-Jhen Yang, Hsin-Chieh Li, Rung-Chuan Lee, **Nae-Lih Wu**^{*}, and Cheng-Che Hsu^{*}, “One-Step Fast Synthesis of Li₄Ti₅O₁₂ Particles Using an Atmospheric Pressure Plasma Jet,” *J. Am. Ceram. Soc.*, in press.
 29. Wen-Chin Chen, Yen-Fang Song, Chun-Chieh Wang, Yijin Liu, Darius T. Morris, Piero A. Pianetta, Joy C. Andrews, Hung-Chun Wu, and **Nae-Lih Wu**^{*}, “Study on Synthesis-Microstructure-Performance Relation of Layered Li-Excess Nickel-Manganese Oxide as Li-Ion Battery Cathode Prepared by High-Temperature Calcination,” *J. Mater. Chem. A*, 2013, 1 (36), 10847 – 10856 (SCI, EI)
 30. Yu-Ting Weng and **Nae-Lih Wu**, “Titanium Carbide@Polypyrrole Core-Shell Nanoparticles Prepared by Controlled Heterogeneous Nucleation for Rechargeable Batteries,” *Chem. Commun.*, 49, 10784—10786 (2013).(SCI, EI)
 31. Yu-Ting Weng and **Nae-Lih Wu**, “High-Performance Poly(3,4-ethylene-dioxythiophene):Polystyrenesulfonate Conducting-Polymer Supercapacitor Containing Hetero-Dimensional Carbon Additives,” *J. Power Sources*, 238, 69–73 (2013).(SCI, EI)
 32. S. L. Kuo, W. R. Liu^{*}, C. P. Kuo, **Nae-Lih Wu**, and H. C. Wu, “Lithium Storage in

- Reduced Graphene Oxides,” *J. Power Sources*, 244, 552-556 (2013).(SCI, EI)
33. Yu-Ting Weng, Chung-Bo Tsai, Wen-Hsien Ho, **Nae-Lih Wu***, “Polypyrrole/carbon supercapacitor electrode with remarkably enhanced high-temperature cycling stability by TiC nanoparticle inclusion,” *Electrochem. Commun.* 27, 172-175 (2013).(SCI, EI)
 34. Chun-Chieh Lin, Hung-Chun Wu, Jing-Pin Pan, Ching-Yi Su, Tsung-Hsiung Wang, Hwo-Shuenn Sheu, and **Nae-Lih Wu***, “Investigation on Suppressed Thermal Runaway of Li-ion Battery by Hyper-Branched Polymer Coated on Cathode,” *Electrochimica Acta* 101, 11–17 (2013).(SCI, EI)
 35. Rung-Chuan Lee, Yen-Po Lin, Yu-Ting Weng, Hsiao-An Pan, Jyh-Fu Lee, and **Nae-Lih Wu,*** “Synthesis of High-Performance MnOx/Carbon Composite as Lithium-Ion Battery Anode by a Facile Co-Precipitation Method: Effects of Oxygen Stoichiometry and Carbon Morphology,” *J. Power Sources*, in press (2014).(SCI, EI)

Conference Papers

1. **Nae-Lih Wu**, “High-Performance Polyacrylate-Based MnO₂ Gel-Polymer- Electrolyte Supercapacitors,” the 1st International Symposium on Enhanced Electrochemical Capacitors, June 29~July 2, Nante, Fance. (2009).
2. **Nae-Lih Wu**, “High-Performance Polyacrylate-Based MnO₂ Gel-Polymer- Electrolyte Supercapacitors,” the 4th Asian Conference of Electrochemical power Systems, November 8-12, Taipei, Taiwan (2009).
3. **Nae-Lih Wu**, “In-situ Study on Working Sn Anode Particles of Li-Ion Battery by Transmission X-Ray Microscopy,” the 216th Annual Meeting of the Electrochemical Society, October 4-9, Vienna, Austria (2009).
4. **Nae-Lih Wu**, “Studies on High-Temperature Cycle Performance of LiFePO₄,” the 12th European Conference on Solid-State Chemistry, September 19-23, Muenster, Germany (2009).
5. **Nae-Lih Wu**, “Study on Long-Term Cycling Behaviors of Aqueous MnO₂ Supercapacitors, the 60th annual meeting of International Society of Electrochemistry, August 16-21, 2009 Beijing, China (2009).
6. **Nae-Lih Wu**, “Novel Reactor Design for Enhanced Photocatalytic Waste-Water Treatment Process,” the 2nd International Green Process Engineering Congress (GPE 2009), Venice, Italy, June 14-17 (2009).
7. **Nae-Lih Wu**, “Enhancing High-Temperature Cycle Performance of LiFePO₄ Cathode,” the 215th Annual Meeting of the Electrochemical Society, San Francisco, May 24-29, U.S.A. (2009).
8. **Nae-Lih Wu**, The 13th Asia Pacific Confederation of Chemical Engineering Congress, October 5-8, Taipei, Taiwan (program organizer) (2010).
9. **Nae-Lih Wu**, “In-Situ Study on Working Li-Alloying Anodes by Transmission X-ray Microscopy,” The 5th Asian Pacific Electrochemical Power Sources, September 17~21, Singapore (invited speaker) (2010).
10. **Nae-Lih Wu**, “Organic-inorganic composite materials for high-performance supercapacitors,” the 8th International Symposium on New Materials and

- Nano-Materials for Electrochemical Systems, July 11-15, Shanghai , China (invited speaker) (2010).
11. **Nae-Lih Wu**, “Binder effects on energy density of supercapacitors,” International Conference of Advanced Capacitors, May 31-June 2, Kyoto, Japan (International Advisory Board member, invited speaker) (2010).
 12. **Nae-Lih Wu**, “In-situ study on Li-alloying anodes by transmission x-ray microscopy,” International Battery Association Meeting and Pacific Power Source Symposium 2010, January 11-15, Waikaloa, Hawaii, U.S.A. (Invited speaker) (2010).
 13. **Nae-Lih Wu**, “Research on Li-alloying anodes of Li-ion batteries -in situ characterization and synthesis,” Advanced Electrochemical Energy Symposium, Dec. 28-30, Hong Kong (keynote speaker) (2011).
 14. **Nae-Lih Wu**, International Congress on Green Process Engineering, December 6 -8, Kuala Lumpur – Malaysia (international scientific committee) (2011).
 15. **Nae-Lih Wu**, “Material and Electrochemical Issues of High-Capacity Electrode Materials for Li-ion Batteries,” Taipei Power Forum, March 17, Taipei, Taiwan (invited speaker) (2011).
 16. **Nae-Lih Wu**, International Symposium of Enhanced Electrochemical Capacitors, June 12-16, Poznan, Poland (international Committee; tutorial instructor: “metal oxide pseudocapacitors”) (2011).
 17. **Nae-Lih Wu**, “Microstructures Evolution of Working Alloying Anodes of Li-Ion Batteries Revealed by In-Situ Transmission X-ray Microscopy,” Materials Research Society Spring meeting, April 24~29, San Francisco, U.S.A. (invited speaker) (2011).
 18. **Nae-Lih Wu**, “Research on conducting polymer/carbon composite supercapacitors: toward enhanced cycle stability and power performance,” The 222nd meeting of the Electrochemical Society, October 7-12, Honolulu, Hawaii, U.S.A. (invited speaker) (2012).
 19. **Nae-Lih Wu**, “Synthesis and characterization of Li-alloying anode materials with porous microstructures,” The American Chemical Society 244 annual meeting, August 19-23, Philadelphia, PA, U.S.A. (invited speaker) (2012).
 20. **Nae-Lih Wu**, “Applications of Synchrotron X-ray Microscopy to in-situ Study on Li-ion Batteries,” The 11th International Conference on X-ray Microscopy, August 5-10, Shanghai, China (invited speaker) (2012).
 21. **Nae-Lih Wu**, “Design, Synthesis and Characterization of Li-Alloying Anode Materials with Porous Microstructures,” The 16th International Meeting of Lithium Batteries, June 17-22, Jeju, South Korea (invited speaker) (2012).
 22. **Nae-Lih Wu**, “Synthesis and characterization of Li-alloying anode materials with porous microstructures,” International Society of Electrochemistry, Spring meeting, April 16-18, Perth, Australia (invited speaker) (2012).
 23. **Nae-Lih Wu**, “Research on high-capacity anodes for Li-ion Batteries,” International Workshop on Energy Materials, February 7-10, Tamil Nadu, India (Plenary speaker) (2012).
 24. **Nae-Lih Wu**, “Current collector issues for Highrate performance of Li-ion Battery electrodes,” International Battery Association meeting, January 9-13, Waikaloa, Hawaii.

(invited speaker) (2012).

25. **Nae-Lih Wu**, “Capacity and SEI Issues for High-Capacity Anodes,” Lithium Ion Battery Discussion, June 16-21, Arcachon, France (invited speaker). (2013)
26. **Nae-Lih Wu**, “Toward Enhanced Energy Storage Capacity and Cycling Stability for Manganese Oxide Supercapacitors,” International Symposium of Enhanced Electrochemical Capacitors, June 3-7, Taormina, Italy (invited speaker) (2013).
27. **Nae-Lih Wu**, Opening remark, The 2nd international Conference on Materials for Energy, May 12-18, Karlsruhe, Germany (Conference Chair) (2013).

Patents

1. **Nae-Lih Wu** and S-Y. Wang, “A process for fabricating crystalline metal oxide materials,” US patent 6168830B1 (2001/1/2-2019/7/28).
2. **吳乃立**、王世源, “具高比表面積的氧化物晶型材料的製作方法,” 中華民國專利第 139569 號(2001/9/1-2019/7/27).
3. **薛立人**、**吳乃立**、**吳典熹**、**藍怡萍**, “含水氧化鐵超高電容器,” 中華民國專利第 156311 號 (2002/6/1-2021/1/10).
4. **薛立人**、**吳乃立**、**吳典熹**、**藍怡萍**, “Supercapacitors made of hydrous Iron oxides,” US Patent 6678147B2 (2004/1/13~2021/1/8).
5. **吳弘俊**、**楊模樺**、**吳乃立**、**劉偉仁**, “二次鋰離子電池之負極材料”, 中華民國專利第 I263702 號 (2006/7/16-2024/12/30); 中國大陸第 ZL2005 1 0066519.0 號 .
6. **吳乃立**、**王世育**、**王凱偉**, “電化學電容器的電極材料”, 中華民國專利第 I267217 號 (2006/1/16-2024/7/7).
7. **吳弘俊**、**蘇靜怡**、**謝秉勳**、**林炳明**、**楊模樺**、**吳乃立**, “具有大電流放電能力之鋰離子二次電池”, 中華民國專利第 I270994 號 (2007/1/11-2025/12/28); 中國大陸第 ZL2005 1 0066519.0 號; 美國第 US7,803,484 號.
8. **吳乃立**、**郭信良**, “高功率電化學電極”, 中華民國專利第 I284997 號 (2007/8/1-2025/8/3)
9. **吳乃立**、**徐金正**, “一種製備光觸媒組合物的方法”, 中華民國專利第 I301776 號 (2008/10/11-2025/2/1)
10. **吳乃立**、**劉偉仁**、**謝登存**、**吳弘俊**, “用於鋰離子二次電池的負極活性材料、其製備方法及含此負極活性材料之鋰離子二次電池”, 中華民國專利第 I332277 號 (2010/10/21-2026/11/12)

11. 吳乃立、趙崧傑, “POROUS TIN PARTICLES AND THE PREPARATION FOR THE SAME”, 美國專利第 8,343,668 號。(2013/1/1-2031/5/3)

Technology Transfer

1. 技術移轉：「儲能電極開發與應用研究」；財團法人紡織產業綜合研究所；6 萬元；2009/3/1~2009/11/30
2. 技術移轉：「超高電容器的製程與材料」；永隆股份有限公司；60 萬元；2009/3~2009/12
3. 技術轉移：「鋰離子石墨負極表面高分子鍍層技術」；榮炭科技股份有限公司；200 萬元；2012/04~2013/03

Honors and Others

1. 臺灣大學特聘教授
2. 2008 臺灣大學工學院優良教師
3. 2009 中國工程師學會工程教授獎
4. 2009 國家科學委員會傑出學者計畫主持人
5. 2009 國立臺灣大學終身特聘教授
6. 李欣潔、張詩敏、斐爾文同學 /指導教授吳乃立教授、徐振哲教授台灣化學工程學會 58 週年年會壁報論文競賽材料在化工上的應用組佳作, 2011/11/25-26
7. 楊乃璇同學 /指導教授吳乃立教授台灣化學工程學會 2012 年會壁報論文競賽電化學組佳作, 2012/11/23-24
8. 本校 101 年研發創新傑出獎
9. 2012 Journal of Power Sources editorial-board member