

# Mengqiang Zhao

Post Doctoral Research Associate  
A. J. Drexel Nanomaterials Institute  
Department Materials Science and Engineering, Drexel University  
3141 Chestnut Street, Philadelphia, PA 19104,  
Phone: 215-400-1413; Email: [mz434@drexel.edu](mailto:mz434@drexel.edu); [zhaomq08@gmail.com](mailto:zhaomq08@gmail.com)

## **HIGHLIGHT**

---

### **Extensive knowledge and hands-on experience in nanomaterial synthesis**

- Carbon nanomaterials: single-walled carbon nanotubes (CNTs), CNT arrays, graphene/CNT hybrids
- Layered double hydroxides (LDHs)
- Hierarchical nanocomposites derived from nanocarbons and metal oxides: double helices, sandwich-like structures, brush-like structures, flower-like structures

### **Hands-on experience in application of carbon nanomaterials for energy storage and other fields**

- For Li-S batteries
- For supercapacitors
- For polymer reinforcement

**Skilled in CVD systems, hydrothermal treatment, TEM, SEM, TGA, Raman, XRD, BET, packaging of battery cells, and electrochemical workstation**

## **EDUCATION**

---

**Postdoc Researcher in Materials Science & Engineering**, Drexel University, Philadelphia, PA

Sep2013 – present

**Ph.D. in Chemical Engineering**, Tsinghua University, Beijing, China,

Sep2008 – Jul2013

*Thesis*: “Hierarchical Assembly of Carbon Nanotubes from Layered Double Hydroxides”.

**B.S. in Chemical Engineering**, Tsinghua University, Beijing, China

Sep2004 – Jul2008

*Thesis*: “Intercalated Growth of Carbon Nanotube Arrays in a Fluidized Bed Reactor”.

## **RESEARCH EXPERIENCE**

---

### **Synthesis of carbon nanomaterials**

- Graphene/single-walled CNT hybrids from LDHs
- N-doped CNT-array double helices from LDHs and N-doped CNT arrays from vermiculite
- Single-walled CNTs with entangled, aligned, and double helical morphology from LDHs
- Multi-walled CNT arrays from natural materials, such as vermiculite, mica, wollastonite, etc.

### **Hierarchical nanocomposites derived from nanocarbons and metal oxides**

- Layered double oxide (LDO)/CNT nanocomposites with interlinked, and double helical structures
- Sandwich-like materials based on alternate CNT arrays and metal oxide layers
- Flower-like CNT arrays grown on spheres
- Brush-like CNT arrays grown on fibrous wollastonite sheet and stick

### **Application of carbon nanomaterials for energy storage and other fields**

- High performance cathode materials for Li-S batteries based on carbon nanomaterials
- Electrochemical performance of carbon nanomaterials for supercapacitors
- Sandwich-like vermiculite/CNT array nanocomposites for energy sorbing
- Vermiculite/CNT array nanocomposites for oil absorption

- Interlinked LDO/single-walled CNT nanocomposites for polymer reinforcement
- Long multi-walled CNTs for polymer reinforcement

#### Catalyst synthesis

- Transition metal-containing LDHs by hydrothermal co-precipitation
- Layered catalysts through incipient wetness impregnation

### **PROFESSIONAL EXPERIENCES**

---

- **Tsinghua University, Dept of Chemical Engineering** **08/2009 – 07/2013**  
Assistant administrator for TEM
- **University of Virginia, Dept of Mechanical&Aerospace Engineering** **09/2010 – 06/2011**  
Visiting scholar for a 9-month research program on thermal interface materials based on CNT arrays
- **Fritz Haber Institute of the Max Planck Society, Berlin** **12/2009 – 01/2010**  
Visiting student for a 1-month research program on characterization of metal nanoparticles on LDHs by TEM
- **Yanshan Petro-Chemical Industry Corporation** **08/2009 – 09/2009**  
Consultant for industrial phenol/acetone production

### **HONORS and AWARDS**

---

- Excellent graduate for graduates in Beijing  
(Award to top 0.1% of graduate in Beijing) July2013
- Excellent thesis for graduates in Tsinghua University  
(Award to top 20 of 28,000 students) July2013
- The top class scholarship of Tsinghua University  
(Award to top 10 of 28,000 students) July2012
- Academic rising star of graduate students in Tsinghua University  
(Award to top 10 of 28,000 students) May2012
- Honored graduated researcher, awarded by the Ministry of Education of China Nov2011
- Excellent thesis for undergraduates in Tsinghua University  
(Awarded to top 5 in undergraduates in Dept. of Chemical Engineering) Jun2008

### **PUBLICATIONS**

---

1. **Zhao M-Q**, Zhang Q, Huang J-Q, Wei F. Hierarchical Nanocomposites Derived from Nanocarbons and Layered Double Hydroxides - Properties, Synthesis, and Applications. *Advanced Functional Materials* 2012;22(4):675-694. **(Featured Article)**
2. **Zhao M-Q**, Zhang Q, Zhang W, Huang J-Q, Zhang Y, Su DS, et al. Embedded High Density Metal Nanoparticles with Extraordinary Thermal Stability Derived from Guest-Host Mediated Layered Double Hydroxides. *Journal of the American Chemical Society* 2010;132(42):14739-14741.
3. **Zhao M-Q**, Zhang Q, Tian G-L, Huang J-Q, Wei F. Space Confinement and Rotation Stress Induced Self-Organization of Double-Helix Nanostructure: A Nanotube Twist with a Moving Catalyst Head. *ACS Nano* 2012;6(5):4520-4529.
4. **Zhao M-Q**, Zhang Q, Jia X-L, Huang J-Q, Zhang Y-H, Wei F. Hierarchical Composites of Single/Double-Walled Carbon Nanotubes Interlinked Flakes from Direct Carbon Deposition on Layered Double Hydroxides. *Advanced Functional Materials* 2010;20(4):677-685. **(Featured on Cover)**
5. **Zhao M-Q**, Liu X-F, Zhang Q, Tian G-L, Huang J-Q, Zhu W-C, Wei F. Graphene/Single-Walled Carbon Nanotube Hybrids: One-Step Catalytic Growth and Applications for High-Rate Li-S Batteries. *ACS Nano* 2012;6(12):10759-10769
6. **Zhao M-Q**, Tian G-L, Zhang Q, Huang J-Q, Nie J-Q, Wei F. Preferential growth of short aligned, metallic-rich single-walled carbon nanotubes from perpendicular layered double hydroxide film. *Nanoscale* 2012;4(7):2470-2477.

7. **Zhao M-Q**, Zhang Q, Huang J-Q, Nie J-Q, Wei F. Advanced Materials from Natural Materials: Synthesis of Aligned Carbon Nanotubes on Wollastonites. *ChemSusChem* 2010;3(4):453-459.
8. **Zhao M-Q**, Zhang Q, Huang J-Q, Tian G-L, Chen T-C, Qian W-Z, Wei F. Towards high purity graphene/single-walled carbon nanotube hybrids with improved electrochemical capacitive performance. *Carbon* 2013;54:403-411.
9. **Zhao M-Q**, Huang J-Q, Zhang Q, Nie J-Q, Wei F. Stretchable single-walled carbon nanotube double helices derived from molybdenum-containing layered double hydroxides. *Carbon* 2011;49(6):2148-2152.
10. **Zhao M-Q**, Zhang Q, Huang J-Q, Nie J-Q, Wei F. Layered double hydroxides as catalysts for the efficient growth of high quality single-walled carbon nanotubes in a fluidized bed reactor. *Carbon* 2010;48(11):3260-3270.
11. **Zhao M-Q**, Zhang Q, Huang J-Q, Wei F. Large scale intercalated growth of short aligned carbon nanotubes among vermiculite layers in a fluidized bed reactor. *Journal of Physics and Chemistry of Solids* 2009;71(4):624-626.
12. **Zhao M-Q**, Huang J-Q, Zhang Q, Luo W-L, Wei F. Improvement of oil adsorption performance by a sponge-like natural vermiculite-carbon nanotube hybrid. *Applied Clay Science* 2011;53(1):1-7.
13. Zhang Q, **Zhao M-Q**, Tang D-M, Li F, Huang J-Q, Liu B, et al. Carbon-Nanotube-Array Double Helices. *Angewandte Chemie-International Edition* 2010;49(21):3642-3645.
14. Zhang Q, **Zhao M-Q**, Liu Y, Cao A, Qian W, Lu Y, et al. Energy-Absorbing Hybrid Composites Based on Alternate Carbon-Nanotube and Inorganic Layers. *Advanced Materials* 2009;21(28):2876-2880.
15. Chen T-C, **Zhao M-Q**, Zhang Q, Tian G-L, Huang J-Q, and Wei F. In Situ Monitoring the Role of Working Metal Catalyst Nanoparticles for Ultrahigh Purity Single-Walled Carbon Nanotubes. *Advanced Functional Materials* 2013. (Accepted)
16. Ji X-Y, **Zhao M-Q**, Wei F, Feng X-Q. Spontaneous formation of double helical structure due to interfacial adhesion. *Applied Physics Letters* 2012;100(26).
17. Tian G-L, **Zhao M-Q**, Zhang Q, Huang J-Q, Wei F. Self-organization of nitrogen-doped carbon nanotubes into double-helix structures. *Carbon* 2012;50(14):5323-5330.
18. Zhang Q, **Zhao M-Q**, Huang J-Q, Nie J-Q, Wei F. Mass production of aligned carbon nanotube arrays by fluidized bed catalytic chemical vapor deposition. *Carbon* 2010;48(4):1196-1209.
19. Zhang Q, **Zhao M-Q**, Huang J-Q, Liu Y, Wang Y, Qian W-Z, et al. Vertically aligned carbon nanotube arrays grown on a lamellar catalyst by fluidized bed catalytic chemical vapor deposition. *Carbon* 2009;47(11):2600-2610.
20. Zhang Q, **Zhao M-Q**, Huang J-Q, Wei F. Comparison of vertically aligned carbon nanotube array intercalated production among vermiculites in fixed and fluidized bed reactors. *Powder Technology* 2010;198(2):285-291.
21. Zhang Q, **Zhao M-Q**, Huang J, Qian W, Wei F. Selective Synthesis of Single/Double/Multi-walled Carbon Nanotubes on MgO-Supported Fe Catalyst. *Chinese Journal of Catalysis* 2008;29(11):1138-1144.
22. Huang J-Q, **Zhao M-Q**, Zhang Q, Nie J-Q, Yao L-D, Su DS, et al. Efficient synthesis of aligned nitrogen-doped carbon nanotubes in a fluidized-bed reactor. *Catalysis Today* 2012;186(1):83-92.
23. Zhang Q, Huang J-Q, **Zhao M-Q**, Qian W-Z, Wei F. Carbon Nanotube Mass Production: Principles and Processes. *ChemSusChem* 2011;4(7):864-889.
24. Jia X, Zhang Q, **Zhao M-Q**, Xu G-H, Huang J-Q, Qian W, et al. Dramatic enhancements in toughness of polyimide nanocomposite via long-CNT-induced long-range creep. *Journal of Materials Chemistry* 2012;22(14):7050-7056.
25. Zhang Q, Huang J-Q, **Zhao M-Q**, Qian W-Z, Wei F. Modulating the diameter of carbon nanotubes in array form via floating catalyst chemical vapor deposition. *Applied Physics a-Materials Science & Processing* 2009;94(4):853-860.
26. Zhang Q, Huang J-Q, **Zhao M-Q**, Qian W-Z, Wang Y, Wei F. Radial growth of vertically aligned carbon nanotube arrays from ethylene on ceramic spheres. *Carbon* 2008;46(8):1152-1158.
27. Huang J-Q, Zhang Q, **Zhao M-Q**, Zhou K, Wei F. Very fast growth of millimeter-tall aligned carbon nanotubes between two stacked substrates coated with a metal catalyst. *Carbon* 2011;49(4):1395-1400.
28. Nie J-Q, Zhang Q, **Zhao M-Q**, Huang J-Q, Wen Q, Cui Y, et al. Synthesis of high quality single-walled carbon nanotubes on natural sepiolite and their use for phenol absorption. *Carbon* 2011;49(5):1568-1580.
29. Huang J-Q, Zhang Q, **Zhao M-Q**, Wei F. The release of free standing vertically-aligned carbon nanotube arrays

from a substrate using CO<sub>2</sub> oxidation. *Carbon* 2010;48(5):1441-1450.

30. Huang J, Zhang Q, **Zhao M-Q**, Wei F. A review of the large-scale production of carbon nanotubes: The practice of nanoscale process engineering. *Chinese Science Bulletin* 2012;57(2-3):157-166.
31. Huang J-Q, Zhang Q, **Zhao M-Q**, Xu G-H, Wei F. Patterning of hydrophobic three-dimensional carbon nanotube architectures by a pattern transfer approach. *Nanoscale* 2010;2(8):1401-1404.
32. Huang J, Zhang Q, **Zhao M-Q**, Wei F. Process Intensification by CO<sub>2</sub> for High Quality Carbon Nanotube Forest Growth: Double-Walled Carbon Nanotube Convexity or Single-Walled Carbon Nanotube Bowls? *Nano Research* 2009;2(11):872-881.
33. Cui CJ, Qian WH, **Zhao MQ**, Ding F, Jia XL, Wei F. High strength composites using interlocking carbon nanotubes in a polyimide matrix. *Carbon* 2013;60:102-108.
34. Zhang W, Zhang Q, **Zhao MQ**, Kuhn LT. Direct writing on graphene 'paper' by manipulating electrons as 'invisible ink'. *Nanotechnology* 2013;24(27):275301.
35. Cui CJ, Qian WZ, **Zhao MQ**, Xu GH, Nie JQ, Jia XL, et al. High-yield Synthesis of Nanohybrid Shish-kebab Polyethylene-carbon Nanotube Structure. *Chinese Journal Chemical Engineering* 23;21(1):37-43.
36. Huang J-Q, Liu X-F, Zhang Q, Chen C-M, **Zhao M-Q**, Zhang S-M, et al. Entrapment of sulfur in hierarchical porous graphene for lithium-sulfur batteries with high rate performance from -40 to 60 °C. *Nano Energy* 2013;2(2):314-321.
37. Zhang S-M, Zhang Q, Huang J-Q, Liu X-F, Zhu W-C, **Zhao M-Q**, Qian W-Z, Wei F. Composite Cathode Containing SWCNT@S Coaxial Nanocables: Facile Synthesis, Surface Modification, and Enhanced Performance for Li-ion Storage. *Particle & Particle Systems Characterization* 2013;30(2):158-165.
38. Zheng C, Qian WZ, Cui CJ, Zhang Q, Jin YG, **Zhao M-Q**, Tan PH, Wei F. Hierarchical carbon nanotube membrane with high packing density and tunable porous structure for high voltage supercapacitors. *Carbon* 2012; 50(14):5167-5175
39. Zhang Q, Xu GH, Huang JQ, Zhou WP, **Zhao M-Q**, Wang Y, Qian WZ, Wei F. Fluffy carbon nanotube produced by shearing vertically aligned carbon nanotube arrays. *Carbon* 2009; 47(2):538-541
40. Zheng C, Qian W, Cui C, Xu G, **Zhao M-Q**, Tian G, et al. Carbon nanotubes for supercapacitors: Consideration of cost and chemical vapor deposition techniques. *Journal of Natural Gas Chemistry* 2012;21(3):233-240.
41. Xu G, Zheng C, Zhang Q, Huang J, **Zhao M-Q**, Nie J, et al. Binder-free activated carbon/carbon nanotube paper electrodes for use in supercapacitors. *Nano Research* 2011;4(9):870-881.
42. Xu G-H, Zhang Q, Huang J-Q, **Zhao M-Q**, Zhou W-P, Wei F. A Two-Step Shearing Strategy To Disperse Long Carbon Nanotubes from Vertically Aligned Multiwalled Carbon Nanotube Arrays for Transparent Conductive Films. *Langmuir* 2010;26(4):2798-2804.
43. Xu G-H, Huang J-Q, Zhang Q, **Zhao M-Q**, Wei F. Fabrication of double- and multi-walled carbon nanotube transparent conductive films by filtration-transfer process and their property improvement by acid treatment. *Applied Physics a-Materials Science & Processing* 2011;103(2):403-411.
44. Yang Z, Zhang Q, Luo GH, Huang JQ, **Zhao M-Q**, Wei F. Coupled process of plastics pyrolysis and chemical vapor deposition for controllable synthesis of vertically aligned carbon nanotube arrays. *Applied Physics a-Materials Science & Processing* 2010;100(2):533-540.

## **CONFERENCE CONTRIBUTION**

---

1. **Zhao M-Q**, Tian G-L, Zhang Q, Huang J-Q, Wei F. Graphene/Single-Walled Carbon Nanotube Hybrids from Layered Double Hydroxides for supercapacitors. Carbon 2012, Krakow, Poland. **(Oral)**
2. **Zhao M-Q**, Tian G-L, Zhang Q, Huang J-Q, Wei F. Direct Growth of Graphene-Single-Walled Carbon Nanotube Hybrids from Layered Double Hydroxides for Energy storage. The 7th International Green Energy Conference & The 1st DNL Conference on Clean Energy, 2012, Dalian, China. **(Oral)**
3. **Zhao M-Q**, Tian G-L, Zhang Q, Huang J-Q, Wei F. Preferential Growth of Short Aligned, Metallic-Rich Single-Walled Carbon Nanotubes from Perpendicular Layered Double Hydroxide Film. Carbon 2012, Krakow, Poland. **(Poster)**
4. **Zhao M-Q**, Zhang Q, Huang J-Q, Tian G-L, Wei F. Hierarchically Self-Assembled 3D Layered Double Hydroxide/Carbon Nanotube Nanoarchitectures. 2012 MRS Spring Meeting & Exhibit, San Francisco, USA.

**(Poster)**

5. **Zhao M-Q**, Huang J-Q, Zhang Q, Luo W-L, Wei F. Improve the Oil Absorption Performance of Natural Vermiculites by Formation of a Sponge-Like Hybrid with Aligned Carbon Nanotubes Intercalated among Clay Layers. 16th International Symposium on Intercalation Compounds, Sec-Ustupky, Czech Republic. **(Poster)**
6. **Zhao M-Q**, Zhang Q, Huang J-Q, Nie J-Q, Wei F. Aligned Carbon Nanotubes from Natural Materials. NT 10, Montreal, Canada. **(Poster)**

## **PATENT**

---

1. **Zhao M-Q**, Zhang Q, Wei F, Tian G-L. Growth of graphene from layered double hydroxides. CN 201210141649.6
2. Wei F, **Zhao M-Q**, Zhang Q, Tian G-L. Fabrication of graphene/carbon nanotube hybrids from layered materials. CN 201210142175.7
3. Wei F, Zhang Q, **Zhao M-Q**. Growth of single/double walled carbon nanotubes using layered double hydroxides. ZL 200910092929.0
4. Wei F, Zhang Q, **Zhao M-Q**. Growth of carbon nanotube array with small diameter on the surface of lamellar catalyst. ZL 200910092930.3
5. Wei F, Zhang Q, **Zhao M-Q**, Qian WZ, Wang Y, Luo GH. A carbon nanotube/layer compound composites and its synthesis. ZL 200710118931.1
6. Wei F, Zhang Q, **Zhao M-Q**. Growth of carbon nanotube array in particles. ZL 200810119666.3