



## Electroactive Functionalization of Graphene as Nanohybrid Materials for Redox Sensing and Energy Storage

Chi, Qijin; Zhu, Nan; Gan, Shiyu; Ulstrup, Jens; Zhang, Pifu

*Publication date:*  
2014

*Document Version*  
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

*Citation (APA):*  
Chi, Q., Zhu, N., Gan, S., Ulstrup, J., & Zhang, P. (2014). *Electroactive Functionalization of Graphene as Nanohybrid Materials for Redox Sensing and Energy Storage*. Abstract from Elecnano6, Paris, France.

---

### General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

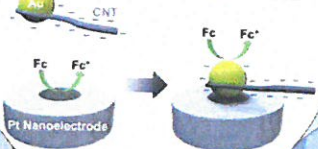
# Electrochemistry at the nanoscale from basic aspect to applications

**ELECNANO6**

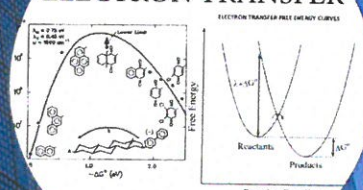
PARIS FRANCE  
MAY 26 - 28 2011

NANOELECTRONICS

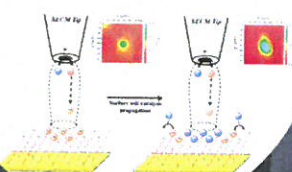
NANOPARTICLES  
and  
ELECTROCHEMISTRY



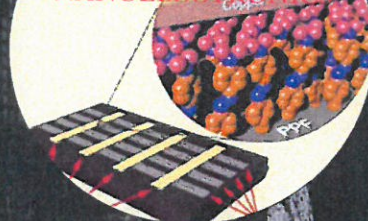
ELECTRON TRANSFER



SCANNING  
ELECTROCHEMICAL  
MICROSCOPE



MOLECULAR  
and  
NANOELECTRONICS



chi's copy **PROGRAMME**

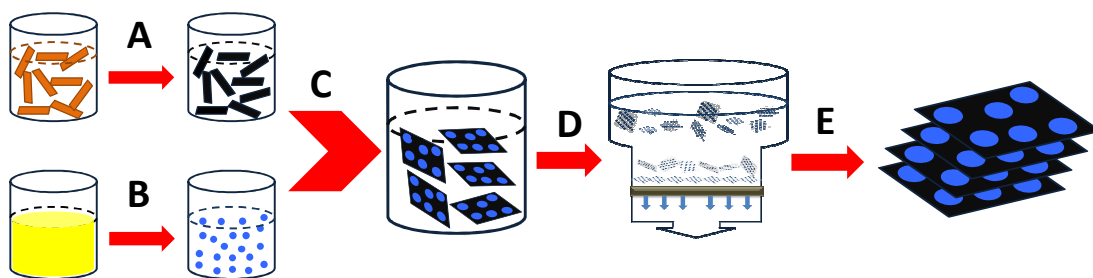


## Electroactive Functionalization of Graphene as Nanohybrid Materials for Redox Sensing and Energy Storage

Qijin Chi, Nan Zhu, Shiyu Gan, Jens Ulstrup, and Pifu Zhang

Department of Chemistry, Technical University of Denmark, 2800 Kongens Lyngby, Denmark. (E-mail: [cq@kemi.dtu.dk](mailto:cq@kemi.dtu.dk); Phone: +45 45252032)

As an atomic-scale-thick two-dimensional material, graphene has emerged as one of the most miracle materials and has generated intensive interest in physics, chemistry and even biology in the last decade.<sup>(1,2)</sup> Nanoscale engineering and functionalization of graphene is a crucial step for many applications ranging from catalysis, electronic devices, sensors to advanced energy conversion and storage.<sup>(3)</sup> In this talk, we *first* present a general theme for functionalization of graphene nanosheets, followed by showing our recent studies on electroactive functionalization of chemically exfoliated graphene materials and their potential applications in sensors, redox-based memory storage and supercapacitors. Our systems studied cover redox-active nanoparticles, electroactive supramolecular ensembles and redox enzymes which are integrated with graphene nanosheets and further transformed into thin films or graphene papers.<sup>(4-7)</sup> Figure 1 shows an example for preparation of *Prussian blue* nanoparticles (PBNPs) doped graphene oxide (GO) and reduced GO (RGO) papers.



**Figure 1. Schematic illustration of preparation of *electroactive, flexible and free-standing* graphene papers.** A) Wet-chemical conversion of GO to RGO via hydrazine reduction, B) synthesis of PBNPs starting from the mixture of  $\text{FeCl}_3$  and  $\text{K}_4\text{Fe}(\text{CN})_6$ , C) preparation of PBNPs-RGO hybrid nanosheets, and D) and E) processes of preparing PBNPs-RGO hybrid paper including filtration, drying and annealing.<sup>(4)</sup> Not drawn to scale.

### References

- (1) M. J. Allen, V. C. Tung, R. B. Kaner, *Chem. Rev.* **2010**, *110*, 132.
- (2) D. R. Dreyer, S. Park, C. W. Bielawski, R. S. Ruoff, *Chem. Soc. Rev.* **2010**, *39*, 228.
- (3) Georgakilas, V. et al. *Chem. Rev.* **2012**, *112*, 6156-6214.
- (4) Gan, S. Y.; Zhong, L. J.; Wu, T. S.; Han, D. X.; Zhang, J.; Ulstrup, J.; Chi, Q.; Niu, L. *Adv. Mater.* **2012**, *24*, 3958-3964.
- (5) Zhu, N.; Han, S.; Gan, S. Y.; Ulstrup, J.; Chi, Q. *Adv. Funct. Mater.* **2013**, *23*, 5297-5306.
- (6) Zhang, P.; Ulstrup, J.; Chi, Q. the manuscript in submission.
- (7) Gan, S. Y.; Zhong, L. J.; Engelbrekt, C.; Zhang, J.; Han, D. X.; Ulstrup, J.; Chi, Q.; Niu, L. *Adv. Mater.* **2014**, the manuscript in submission.

### Acknowledgements

This project is supported by the Danish Research for Technology and Product Science (Project No. 12-127447). S.Y.G. acknowledges the Universities Denmark for a visiting PhD studentship.