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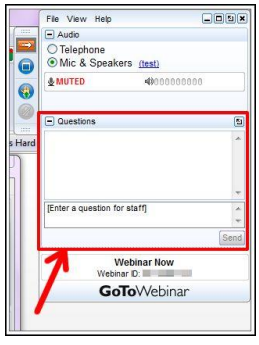

"Why am I muted?"
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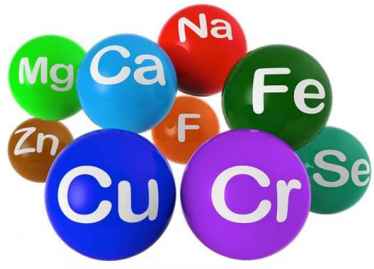

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Fan of the Week

Katalin Korpany
Materials Scientist, McGill University,
ACS member for 6 years strong!

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2017 Industrial Science Series

ACS Chemistry for Life®

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Stan Frey of Honeywell profiles their Green Jet Fuel™ program, which can reduce the greenhouse gas emissions by 65 to 85% when compared to petroleum based fuels.

TERA-print: From Academic Discovery to A Commercial Desktop Fab
Chad Mirkin discusses the development of a suite of novel nanofabrication instruments.

The Good, The Bad and the Uncertain: Public Perception of the Chemical Enterprise
Mark Jones covers the history of chemistry's negative reputation and how we can learn from the past to improve its future.

Insourcing and Outsourcing in R&D: Trends in the Pharma Industry
Michael Trova covers the pros and cons of the traditional outsourcing model as the rising trend of working with an insourced partner.

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Thursday, June 8, 2017

HPLC Method Development Bootcamp: *A Straight-Forward Approach to Solve 80% of Separation Problems*

Co-produced with ACS Professional Education

Lee Polite, Founder and President, Axion Analytical Labs
Bryan Tweedy, Manager, Office of Professional Education, American Chemical Society

Thursday, June 15, 2017

Exploring Alternative Careers in Chemistry: *Part 2*

Co-produced with ACS Younger Chemists Committee, the ACS Women Chemists Committee, and C&EN Jobs

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Jyllian Kemsley, Senior Editor, *Chemical & Engineering News*

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ACS Webinars
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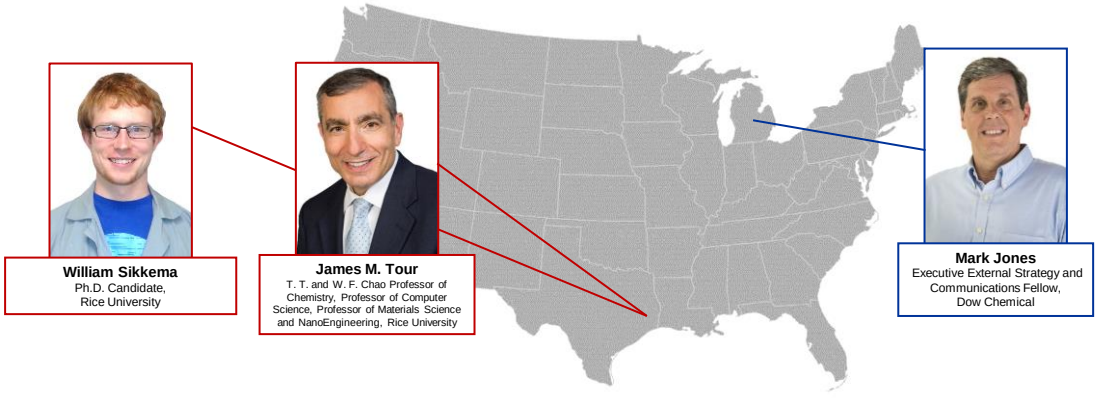
*"**Advances in Graphene Nanotechnology:** Making the Paralyzed Walk"*
Session 5 of the 2017 Industry Science Series



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ADVANCES IN GRAPHENE NANOTECHNOLOGY

MAKING THE PARALYZED WALK

JAMES M. TOUR AND WILLIAM SIKKEMA OF RICE UNIVERSITY

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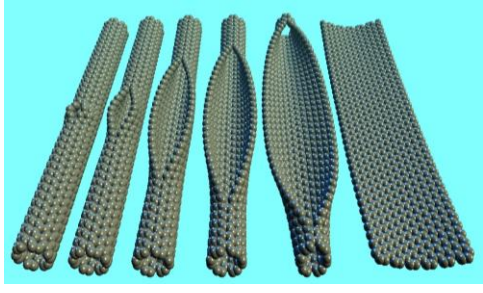
Longitudinal Unzipping of CNTs to Form Graphene Nanoribbons (GNRs)



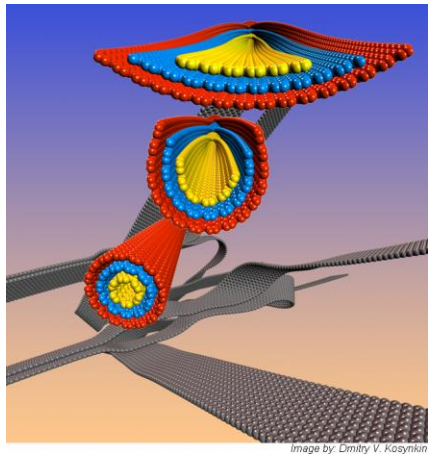


Image by: Dmitry V. Kosynkin

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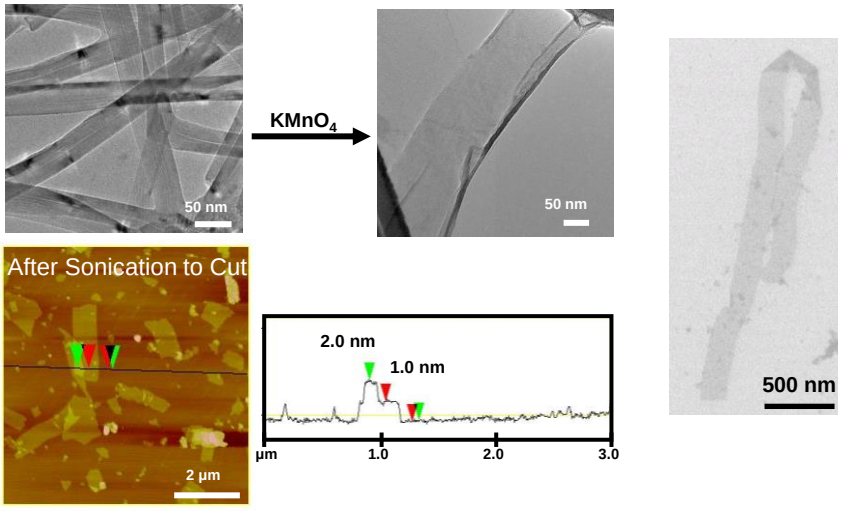
Longitudinal Unzipping of CNTs to Form Graphene Oxide Nanoribbons (GONRs)



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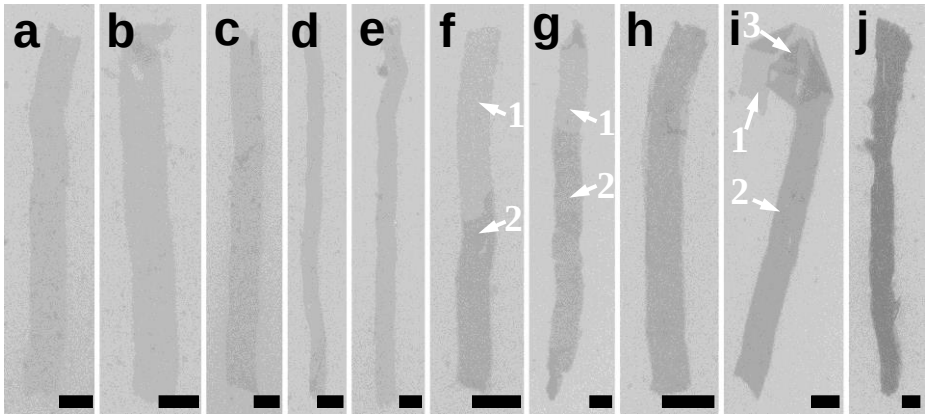
Alignment of Nanoribbons (no picture rotation)



SEM images of **(a-e)** monolayer ribbons, **(f,g)** GNRs with coexisting mono- and bi-layer fragments, **(h,i)** bilayer ribbons, and **(k)** a multilayer stack of GNRs. All scale-bars in (a-j) are 250 nm, except for (d) at 500 nm. All GNRs have a width of 180-320 nm, they can be up to several µm long, as shown in (d) at 6.1 µm and (e) at 3.2 µm. All scale-bars are 250 nm except for (e) at 500 nm.

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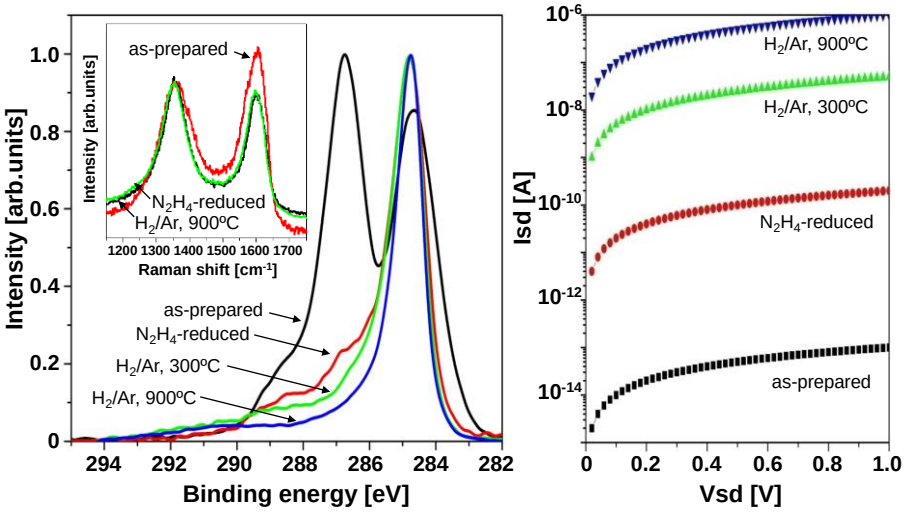
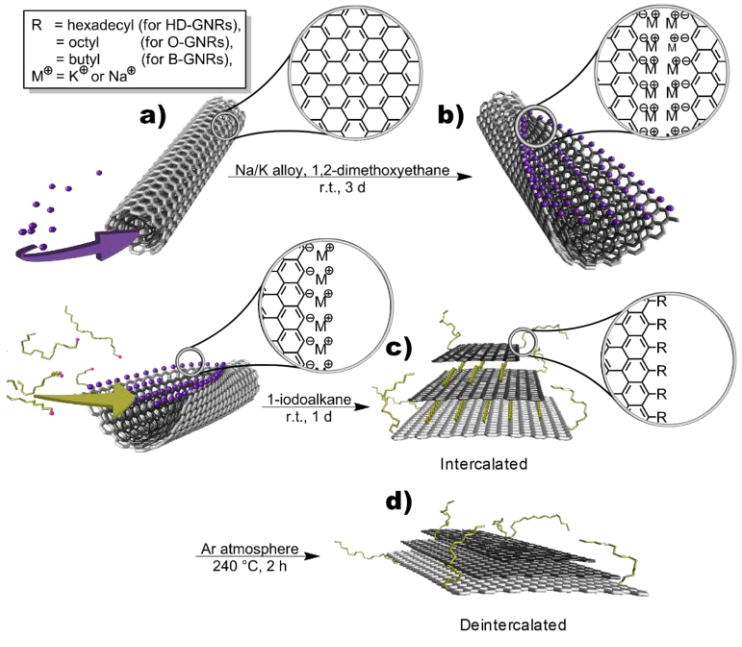
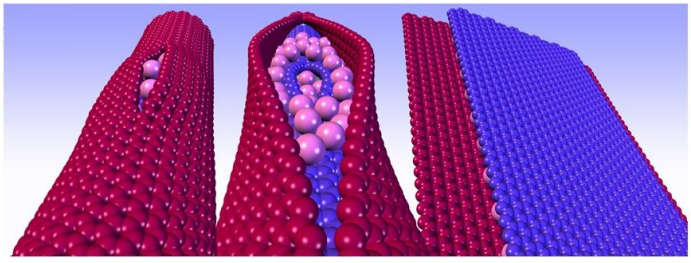
Reduction of the Ribbons

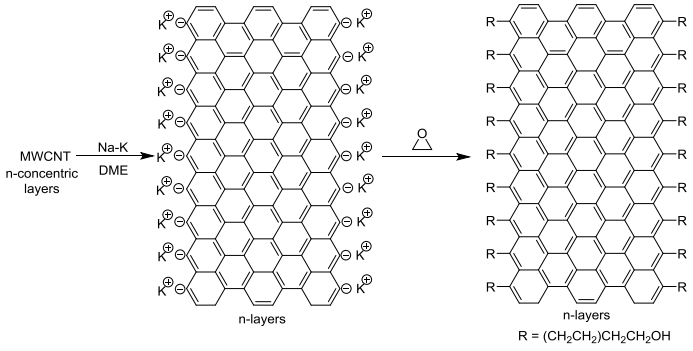


Reductive splitting & in-situ modification



Na-K MWCNTs to Form Graphene Nanoribbons





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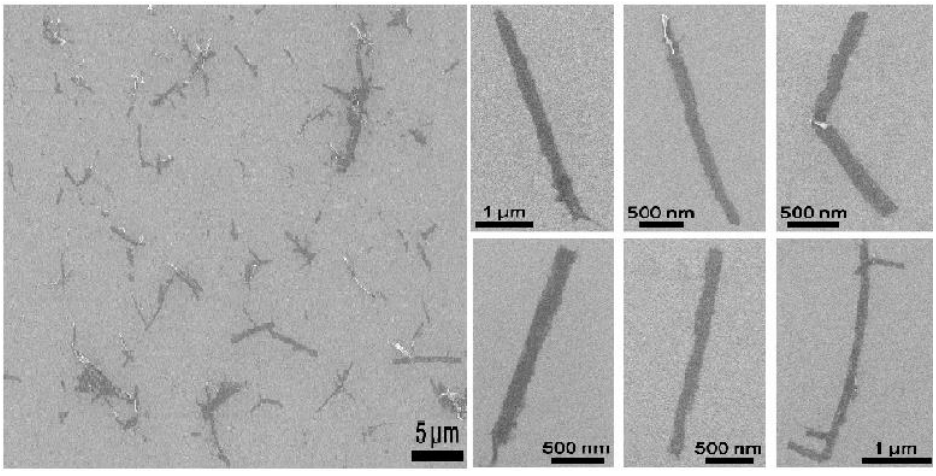
Split MWCNTs to Form Graphene Nanoribbon Stacks



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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

Carbon nanotubes are different than graphene nanoribbons. **Is there a way to covalently functionalize a carbon nanotube to render it water soluble while maintaining its high conductivity?**

A) No, because covalent functionalization would destroy its pi-conjugation

B) Yes, since its pi-conjugation would still largely remain after covalent functionalization

C) Yes, because one could functionalize the ends without affecting the central part of the nanotube

D) No, because any functionalization, covalent or non-covalent, would shield the nanotube from being accessible for use

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J Neurosurg Pediatrics 11:575–583, 2013

Biocompatibility of pristine graphene for neuronal interface

Laboratory investigation

Deshdeepak Sahni, M.D.,[1,2] Andrew Jea, M.D.,[1,2] Javier A. Mata, M.D.,[1,2] Daniela C. Marcano, M.S.,[3] Ahilan Sivaganesan, B.A.,[1,2] Jacob M. Berlin, Ph.D.,[3] Claudio E. Tatsui, M.D.,[1] Zhengzong Sun, Ph.D.,[3] Thomas G. Luerssen, M.D.,[1,2] Shiyun Meng,[4] Thomas A. Kent, M.D.,[5,6] and James M. Tour, Ph.D.[3]

[1]Department of Neurosurgery, Baylor College of Medicine; [2]Division of Pediatric Neurosurgery, Texas Children's Hospital; [3]Smalley Institute for Nanoscale Science and Technology, Chemistry Department, Rice University; [5]Interdepartmental Program in Translational Biology and Molecular Medicine, Departments of Neurosurgery and Neurology, Baylor College of Medicine; [6]Michael E. DeBakey VA Medical Center, Houston, Texas; and [4]College of Environment and Biotechnology, Chongqing Technology and Business University, Chongqing, People's Republic of China

Results. Statistically significant differences in the percentage of live or dead neurons were noted between graphene and PDL surfaces, as well as between the PDL-coated and bare surfaces, but there was little difference in cell viability between graphene-coated and bare surfaces. There were significantly lower LDH levels in the graphene-coated samples compared with the uncoated ones, indicating that graphene was not more cytotoxic than the bare control surface. According to phase contrast microscopy, neurons attached to the graphene-coated surface and were able to elaborate long, neuritic processes suggestive of normal neuronal metabolism and morphology.

Conclusions. Further use of graphene as a bioscaffold will require surface modification that enhances hydrophilicity to increase cellular attachment and growth. Graphene is a nanomaterial that is biocompatible with neurons and may have significant biomedical applications.
(http://thejns.org/doi/abs/10.3171/2013.1.PEDS12374)

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Neurons grow on graphene

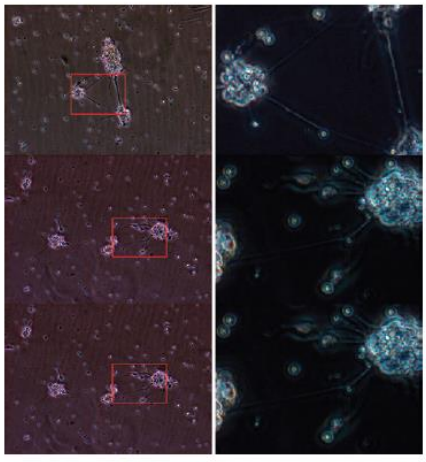

FIG. 2. Phase contrast micrographs of live neuronal cell growth. **Left:** Neurons cultured on graphene at Day 7. Significant linear neurite outgrowth is noted, with normal morphology and evidence of synapse formation. Original magnification ×10 hpf (Phase 1). **Right:** Magnified details of *red insets*. Original magnification ×40 hpf (Phase 2).

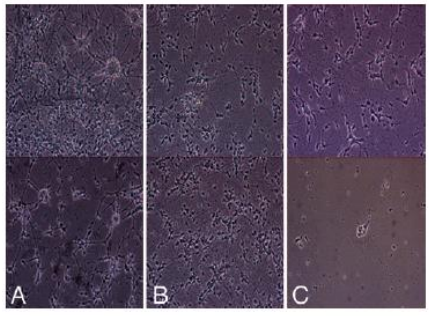

FIG. 4. Neurons cultured at 14 *(upper)* and 20 *(lower)* days. **A:** Graphene surface. **B:** Poly-D-lysine–coated surface. **C:** Bare surface. Robust growth of neurons and neurites can be seen at 14 days on graphene, with decreasing density at 20 days, which is similar to the pattern on bare controls. Original magnification ×10 hpf (Phase 1).

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Editor: James I. Ausman, MD, PhD University of California, Los Angeles, CA, USA

Original Article

Biocompatibility of reduced graphene oxide nanoscaffolds following acute spinal cord injury in rats

Ali H. Palejwala[1,5], Jared S. Fridley[1,5], Javier A. Mata[1,5], Errol L. G. Samuel[6], Thomas G. Luerssen[1,5], Laszlo Perlaky[2,8], Thomas A. Kent[3,4,9], James M. Tour[6,7], Andrew Jea[1,5]

Departments of [1]Neurosurgery, [2]Pediatrics, [3]Neurology, and [4]Interdepartmental Program in Translational Biology and Molecular Medicine, Baylor College of Medicine, [5]Division of Pediatric Neurosurgery, Texas Children's Hospital, Houston, Departments of [6]Chemistry, [7]Chemistry and Materials Science and NanoEngineering, Rice University, [8]Research and Tissue Support Services Core Laboratory, Texas Children's Cancer and Hematology Services, [9]Center for Translational Research in Inflammatory Diseases, Michael E. DeBakey VA Medical Center, Houston, Texas, USA

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*Corresponding author

Results: The graphene nanoscaffolds adhered well to the spinal cord tissue. There was no area of pseudocyst around the scaffolds suggestive of cytotoxicity. Instead, histological evaluation showed an ingrowth of connective tissue elements, blood vessels, neurofilaments, and Schwann cells around the graphene nanoscaffolds.

Conclusions: Graphene is a nanomaterial that is biocompatible with neurons and may have significant biomedical application. It may provide a scaffold for the ingrowth of regenerating axons after spinal cord injury.

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Neurons and spinal tissue show good ingrowth into graphene gels

Surgical Neurology International 2016, 7:75

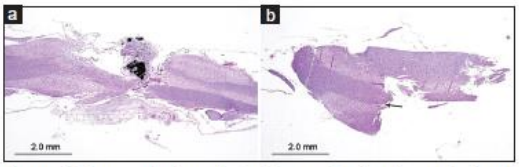

Figure 2: Representative photomicrographs showing spinal cord injury development after hemispinal cord transection at the T2 level (a) with reduced graphene oxide nanoscaffold performed immediately after transection and (b) without nanoscaffold implantation (control group). Notice the area devoid of tissue (*arrow*) at the lesion site in the control slide, suggesting possible pseudocyst formation. By contrast, cell proliferation (*asterisk*) is exuberant with implantation of the nanoscaffold, and no cavity is evident. Hematoxylin and eosin bar = 2 mm

Surgical Neurology International 2016, 7:75

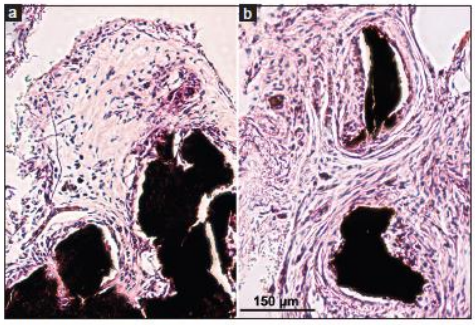

Figure 4: Representative phase contrast photomicrographs illustrate structural regeneration of spinal cord tissue using a nanoscaffold. The incompletely transected spinal cord is bridged using a reduced graphene oxide scaffold for tissue ingrowth and cell infiltration. (a), Spinal cord adheres well to the nanoscaffold. (b), Loose connective tissue forms between the spinal cord tissue and the reduced graphene oxide scaffold. Bar = 150 µm

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Editor: Prof. Sergio Canavero, MD (US FMGEMS) and Prof. Xiaoping Ren, MD

Original Article

Spinal cord fusion with PEG-GNRs (TexasPEG): Neurophysiological recovery in 24 hours in rats

C-Yoon Kim[1,2,†], William K. A. Sikkema[4,†], In-Kyu Hwang[1], Hanseul Oh[2], Un Jeng Kim[3], Bae Hwan Lee[3], James M. Tour[4,5,6]

[1]Department of Stem Cell Biology, School of Medicine, Konkuk University, Seoul, Korea, [2]Department of Laboratory Animal Medicine, College of Veterinary Medicine, Seoul National University, Seoul, Korea, [3]Department of Physiology, Brain Korea 21 PLUS Project for Medical Science, Yonsei University College of Medicine, Seoul, Korea, [4]Department of Chemistry, [5]The NanoCarbon Center, [6]Department of Material Science and Nanoengineering, Rice University, Houston, Texas, USA

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*Corresponding author
†These authors equally contributed to this work.

Methods: Laminectomy and transection of cervical spinal cord (C5) was performed on Female Sprague-Dawley (SD) rats. After applying PEG-GNR on the severed part, electrophysiological recovery of the reconstructed cervical spinal cord was confirmed by somatosensory evoked potentials (SSEPs) at 24 h after surgery.

Results: While no SSEPs were detected in the control group, PEG-GNR treated group showed fast recovery of SSEPs at 24 h after the surgery.

Conclusion: In this preliminary dataset, for the first time, we report the effect of a novel form of PEG with the goal of rapid reconstruction of a sharply severed spinal cord.

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Neuron regeneration

Peripheral nervous system (PNS)

Muscle tissue

Motor neuron
cell body

Axon

Central nervous system (CNS)

CNS neuron
Cell body

Axon

Dendrite

CNS neuron
Cell body

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Neuron regeneration

Peripheral nervous system (PNS)

Muscle tissue

Central nervous system (CNS)

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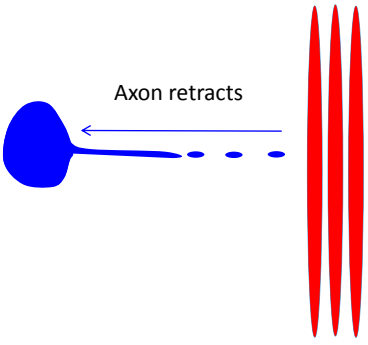
Neuron regeneration

Peripheral nervous system (PNS)

Muscle tissue

Axon retracts



Central nervous system (CNS)

Axon retracts

Dendrite retracts

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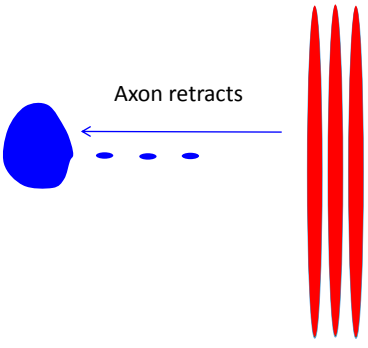
Neuron regeneration

Peripheral nervous system (PNS)

Muscle tissue

Axon retracts



Central nervous system (CNS)

Axon retracts

Dendrite retracts

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Neuron regeneration

Peripheral nervous system (PNS)

Muscle tissue

Axon regrowth

Environment encourages new growth and repair

Central nervous system (CNS)

Dendrite regrowth

Axon regrowth

Environment is hostile to new growth

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Neuron regeneration

Peripheral nervous system (PNS)

Muscle tissue

Connection re-established

Central nervous system (CNS)

Connection **not** re-established

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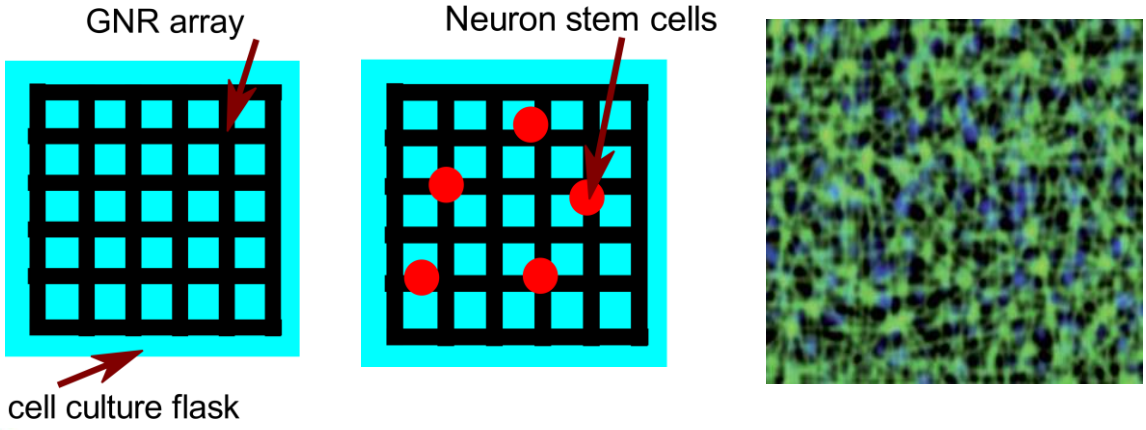
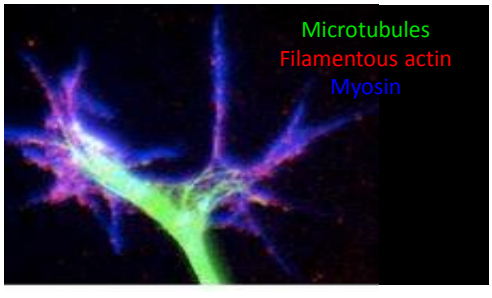
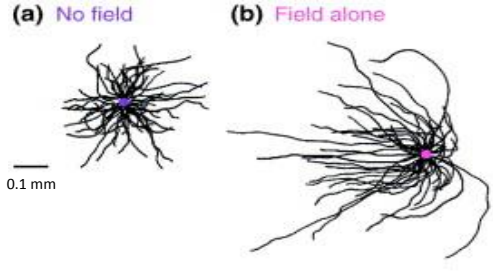
Neurons growing on non-functionalized GNR in a 2D system



Akhavan, O.; Ghaderi, E. *J. Mater. Chem. B* **2013**, *1*, 6291–6301

How neurons grow



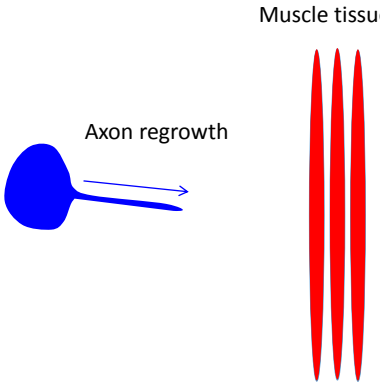


Sharp filamentous actin protrusions from end of growth cone sense
Electrical and physical environment and direct the tip of the neuron's process

McCaig, et al. Trends in Neuroscience 25(7) 354

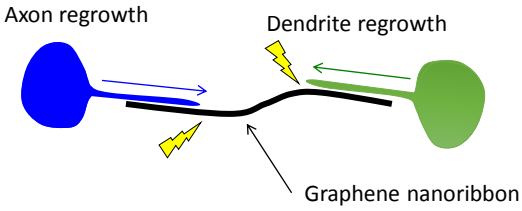
Graphene nanoribbons positionally inform neuron regeneration

Peripheral nervous system (PNS)



Environment encourages new growth and repair

Central nervous system (CNS)



Environment is hostile to new growth, **but** graphene nanoribbons may act as a favourable, electrically active substrate

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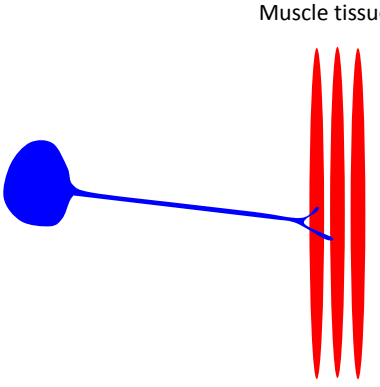
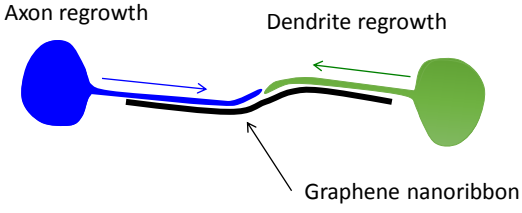
Graphene nanoribbons positionally inform neuron regeneration

Peripheral nervous system (PNS)



Connection re-established

Central nervous system (CNS)



Connection re-established

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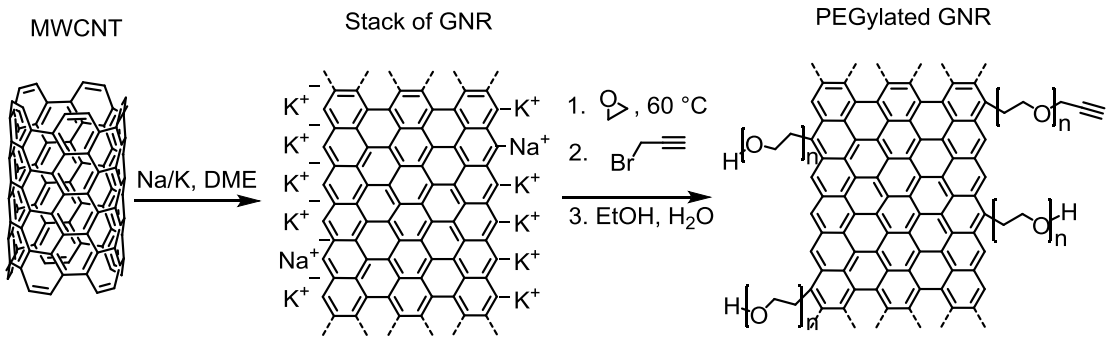
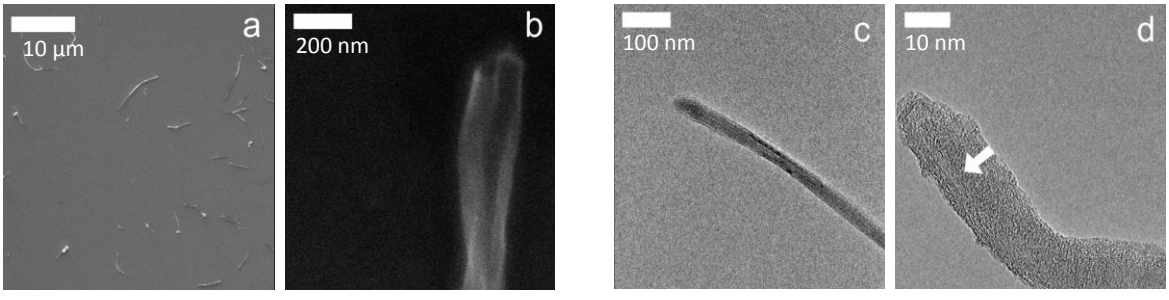
Water solubility of GNRs is critical in a 3D system of neurons



Synthesis modified from: Kosynkin, D.; et. al. ACS Nano, **2011**
Kosynkin, et. al. Tour, J. M. *Nature* **2009**, *458*, 872–876

What do PEG-GNRs look like?



Scanning electron microscopy

Transmission electron microscopy

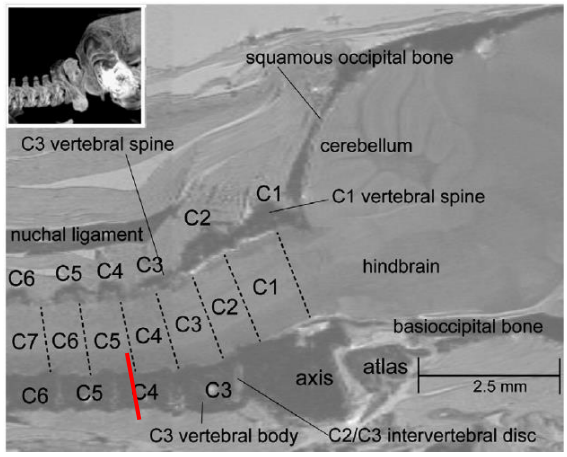
Sikkema, et. al. SNI (accepted)

TEM courtesy of Drew Metzger

How is the surgery performed?

1. Surgical window opened exposing spinal cord
2. Spinal cord supported with a gentle hook
3. Cord severed with a sharp blade
4. One drop of 1% PEG-GNR in PEG 600 applied to blunt ends of spinal cord
5. Surgical window closed and sutured

Spinal cord hook



Harrison, et. Al. Neuroimage 68 (2013) 22-29

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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

How are the nanoribbons aligned parallel with the spinal cord?

- Electrical fields
- Magnetic fields
- Shear forces
- Individually with a nano-manipulator
- Black Magic

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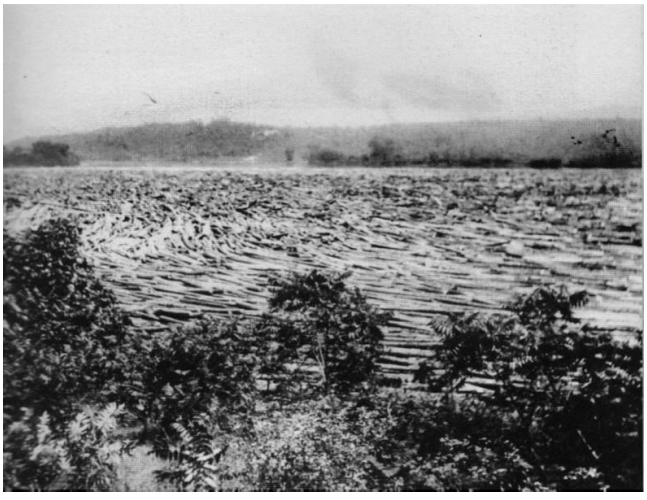
Logs transported by river in 1903



They align similarly to the way logs align in a river with movement of the river

http://historycruise.blogspot.com/p/log-drives-on-river.html

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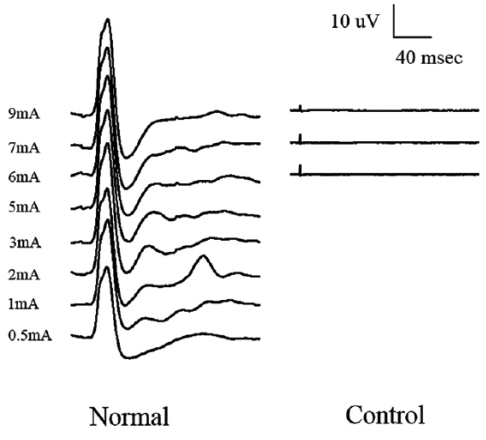
How do we measure recovery?

1. Before functional recovery is observable, electrical connectivity can be measured
2. Somatosensory evoked potentials (SSEP) show communication between extremities of the animal with its brain



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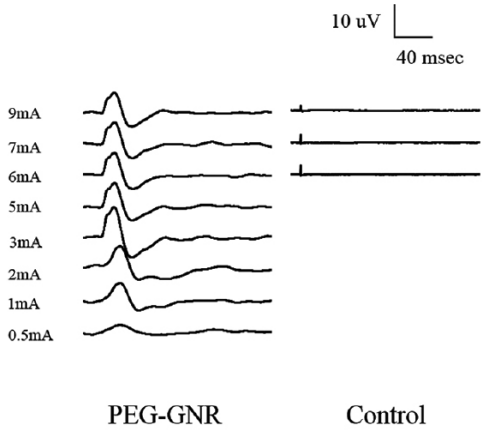
Somatosensory evoked potential recovery

1. Showing recovery of SSEP signals after only 24 hours
2. Electrical connection prevents further degradation of distal neurons



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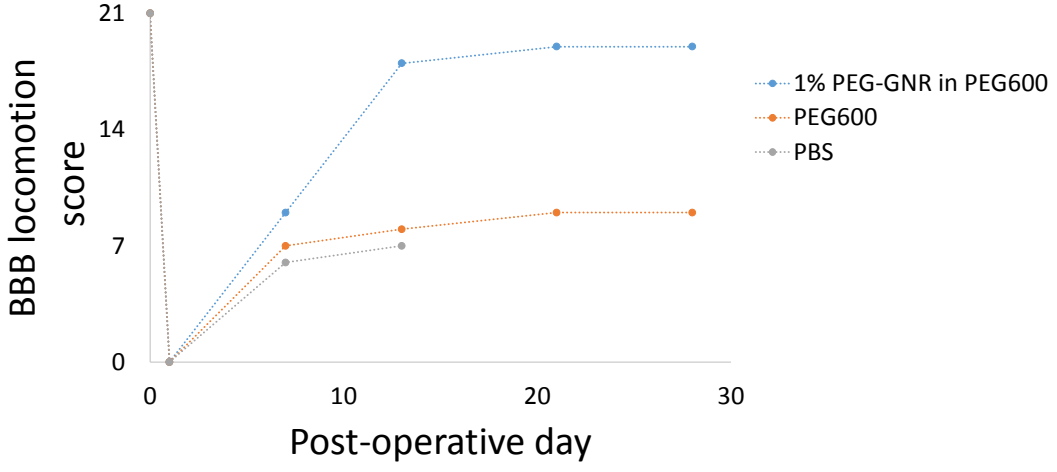
Functional recovery



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Laminectomy and complete transection of cervical spinal cord at C5. Then application of 1 wt% pegylated-graphene nanoribbons (PEG-GNR or "Texas PEG") in (polyethylene glycol)-600. Shown is the rat mobility at 7, 14 and 21 days post surgery.

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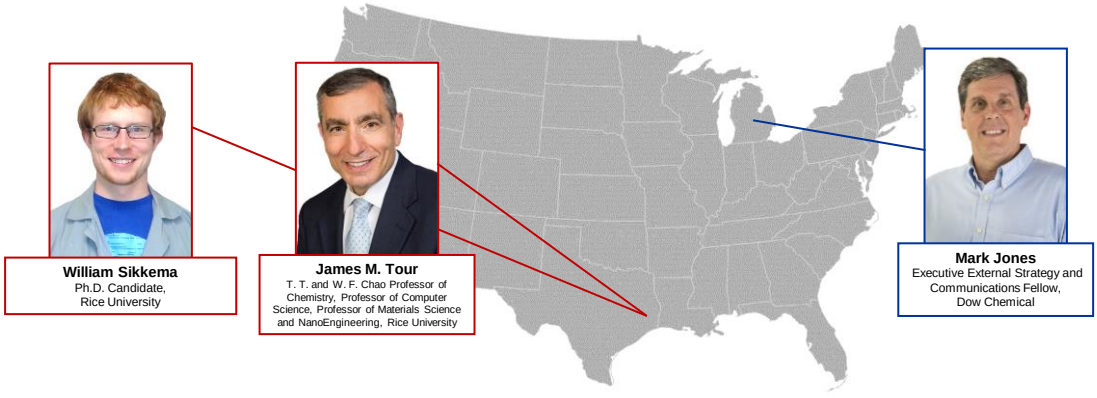

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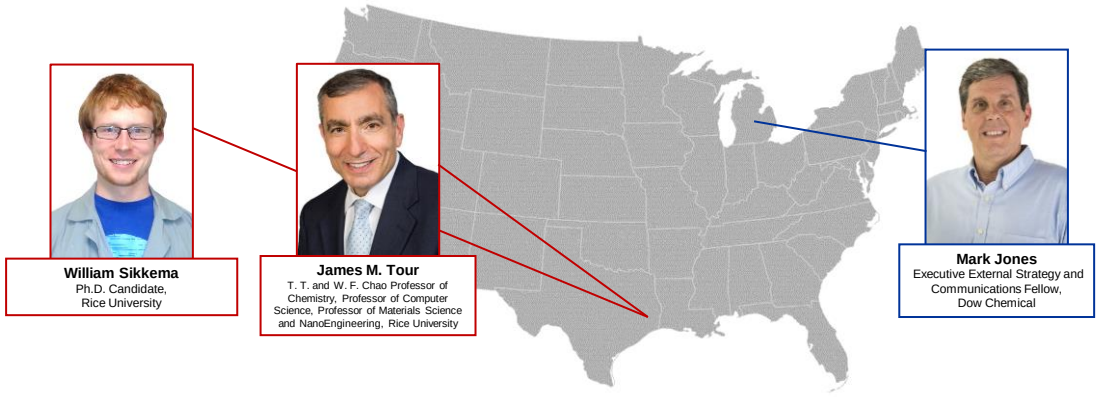

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