



Nanoscale Science & Engineering

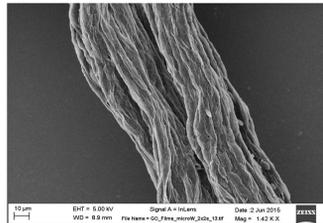
Morristown High School, Morristown, NJ

Marcel Kolker, BSME, MBA

Rutgers University RET in Graphene Oxide Fiber Production

The goal of this lesson is to introduce students to the nanomaterial graphene and its many applications in energy technologies and energy sustainability.

Through the Organic Electronics lesson, students will learn about the way in which graphene's properties can be harnessed in graphene-based fibers (GBFs), which can eventually lead to wearable technology and improved fuel efficiency in airline & aerospace industries.



The methodology for wet-spinning of GBFs in the lab is similar to the sodium alginate based capture of graphite in the student lesson. In both cases, a coagulation bath of CaCl₂ is used, and the fibers are held together through calcium ion bonding. Resistances in both cases are measured and optimized.

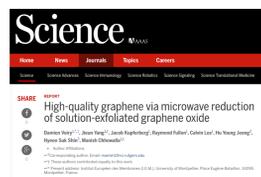
Students will create macro-models of GBFs using graphite in place of graphene, and the addition of sodium alginate as a bonding agent. As with GBFs, students will test and optimize fibers for minimum resistivity.



Students can vary graphite content, sodium alginate concentration/viscosity, and calcium ion concentration in the coagulation bath.



Students will work with available materials to set-up a production procedure for the optimization of fibers. The resulting report will include measured quantities, equipment, methods, resistivity calculation data, results and a conclusion.



Research on GO Fibers in the Nano-materials and Devices Lab at Rutgers University was featured in Science, September 2016

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Teaching Nano in the High School Classroom

Units of Study

I. Size & Scale

- a. Powers of Ten
- b. There's Plenty of Room at the Bottom
- c. Moore's Law, quantum computing



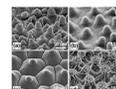
II. Tools of the Nanoscale

- a. SEM, STM microscopy
- b. AFM simulation
- c. SEM remote access via NACK



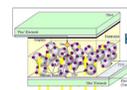
III. Size Dependent Properties

- a. SA/V ratio
- b. Viscosity, mobility & Reynold's number
- c. Light-matter interaction



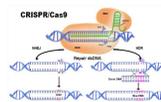
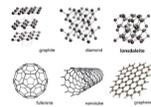
IV. Forces & Interactions

- a. Hierarchy of forces
- b. Colloids, solutions, suspensions
- c. Hydrophobic & hydrophilic properties



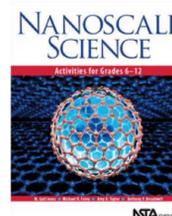
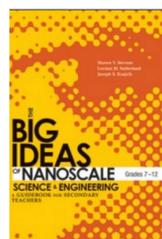
V. Polymer & Materials Science

- a. Carbon allotropes
- b. Self assembly
- c. Polymer cross-linking
- d. Nanocomposites
- e. Bionanoengineering



I. Social & Ethical Implications

K-12 Resources



Student & Teacher Outreach

Project Based Learning

Nanoscale Science & Engineering students at Morristown High School take part in an educational outreach project in which they are responsible for organizing and hosting an event for younger students.



Their goal is to educate and excite students about nanoscience and the ways in which it affects our lives.

Teacher Workshop

At Stevens Institute of Technology during summer 2016 I hosted a nanoscience workshop for middle and high school teachers.

Nanoscience is at the intersection of biology, physics, chemistry and technology

Register at: <http://tinyurl.com/SummerNano>

Nanoscience Educator Workshop
For Middle and High School Teachers

Learn about the nanoscale revolution in science, and come away with activities you can use in your general science classroom. Or take it all and turn it into a nanoscience elective course! Topics may include:

- Powers of Ten activities
- Surface area to volume ratio
- Quantum effects
- Hydrophobicity, hydrophilicity

References

- <https://www.pearsonhighered.com/program/Ratner-Nanotechnology-A-Gentle-Introduction-to-the-Next-Big-Idea/PGM148060.html>
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Acknowledgements

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