Ultrashort Carbon Nanotubes for Space Radiation Sickness

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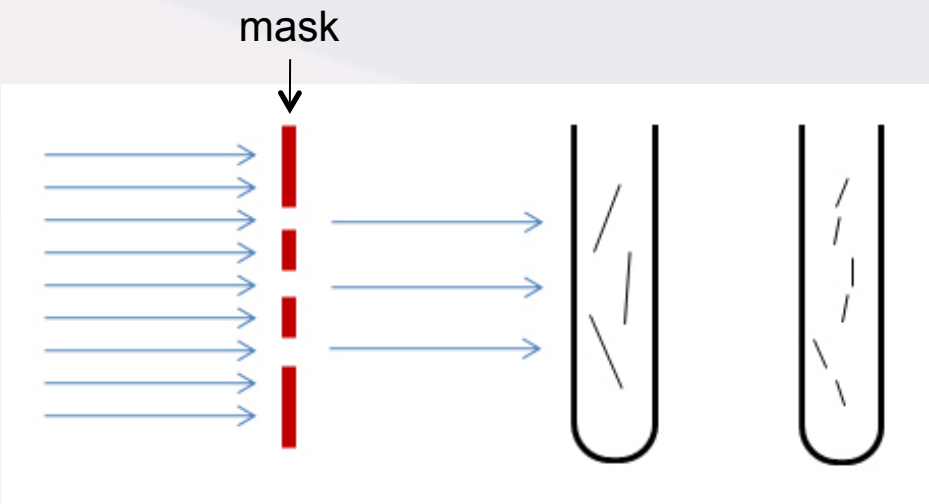
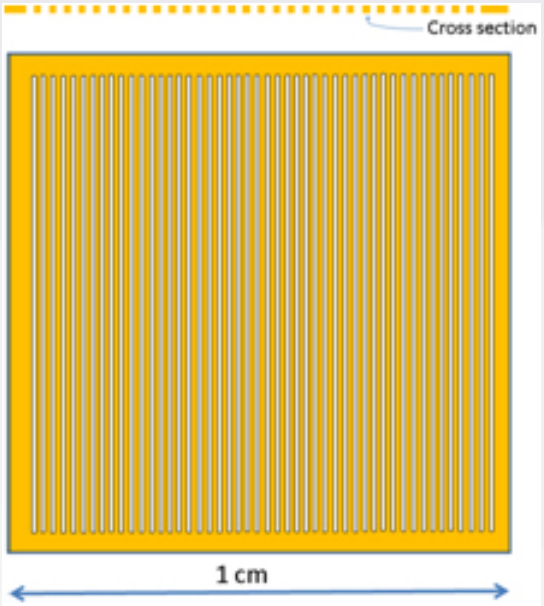
- **The "Hook":** Carbon nanotubes are potent free-radical scavengers, and might be effective treatment for space radiation sickness.
- **The Problem:** CNTs, as made, are too long—poorly distributed in tissue.
- **Potential Solution:** Shorten CNTs by exposure to X-rays.
- **Approach:** Use high-intensity X-ray beam-line at the Stanford Synchrotron Radiation Lab (SSRL) in attempt to "cut" CNTs; analyze by light scattering.



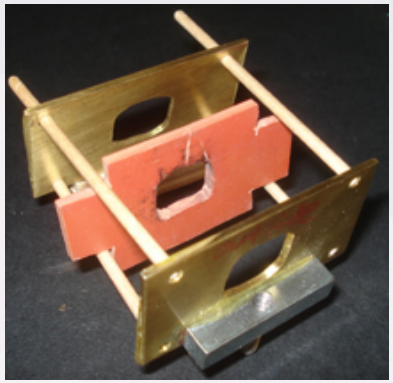


← mask

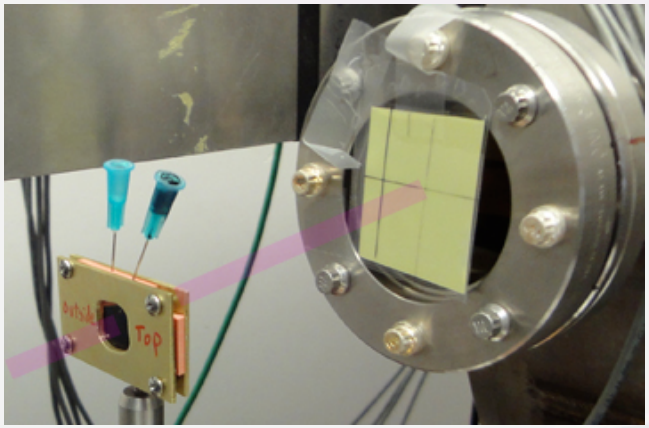
A **mask** may help to define the desired CNT length (by the periodic spacing of open slits), but is not necessary for proof of concept studies.

Cutting of CNTs by High-intensity X-rays
Experimental Details

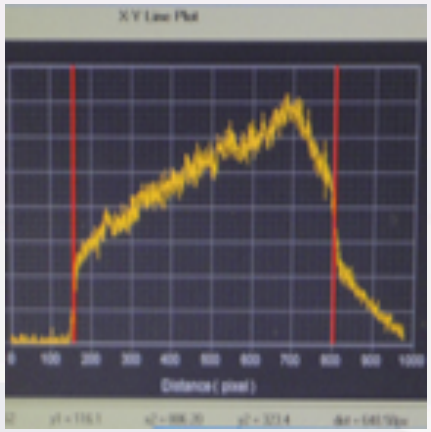
- Amazingly, over the course of its 37 year history, the SSRL has never before been used for “materials processing.” No sample chambers were available at SSRL.
- We fabricated a novel device for containing suspensions of CNTs that minimized the path-length, to optimize X-ray cutting efficiency.



Exploded view of the sample chamber for containing suspensions of CNTs (actual components shown, connected by toothpicks). The thickness and opening dimensions of the red rubber gasket define the volume of the sample chamber. Thin glass coverslips (not shown) serve as the sample chamber windows. For optimum cutting efficiency, a thin sample (thin pathlength) is desired. The sample chamber was made at Ames Research Center.



CNTs were introduced into the chamber via syringe needles (also provide pressure-relief). Beam path shown in pink (left). The beam profile was monitored in real time (right).

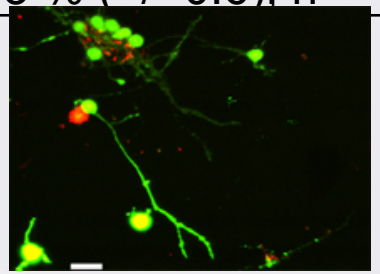


Cutting of CNTs by High-intensity X-rays
Results / Future Directions

Results: Brief exposure to X-rays (~5 keV) resulted in a 4-fold increase in the smallest size fraction of CNTs. Statistically significant result.
Proof of concept achieved!

% of CNTs in smallest size category (< 22 μm), determined by laser light-scattering	
Before X-ray Exposure	**After X-ray Exposure**
0.3 % (+/- 0.6), n = 10	1.3 % (+/- 0.5), n = 10

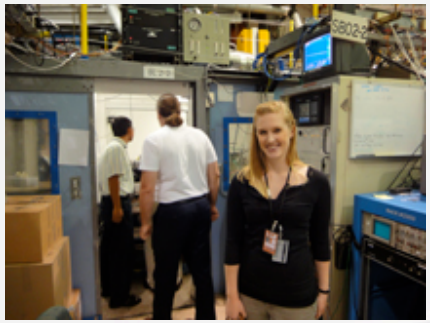
Biological testing revealed good biocompatibility (no change versus native CNTs),a necessary requirement for potential drug development.



Live/dead stain revealed good biocompatibility of neuronal cells in presence of X-ray - treated CNTs.

Future Directions:

- Reduce X-ray energy/decrease pathlength to increase CNT cutting efficiency.
- Additional tests of biocompatibility and tests of free-radical scavenging potency.
- Invention disclosure/patent application underway.



Acknowledgements:

- SSRL staff at the **SLAC National Accelerator Facility** (a DOE facility)
- Bart Johnson (SSRL)
- Jon Rask (NASA Ames)
- Clara McCrossin (NASA Ames)
- Jeff Smith (NASA Ames)