

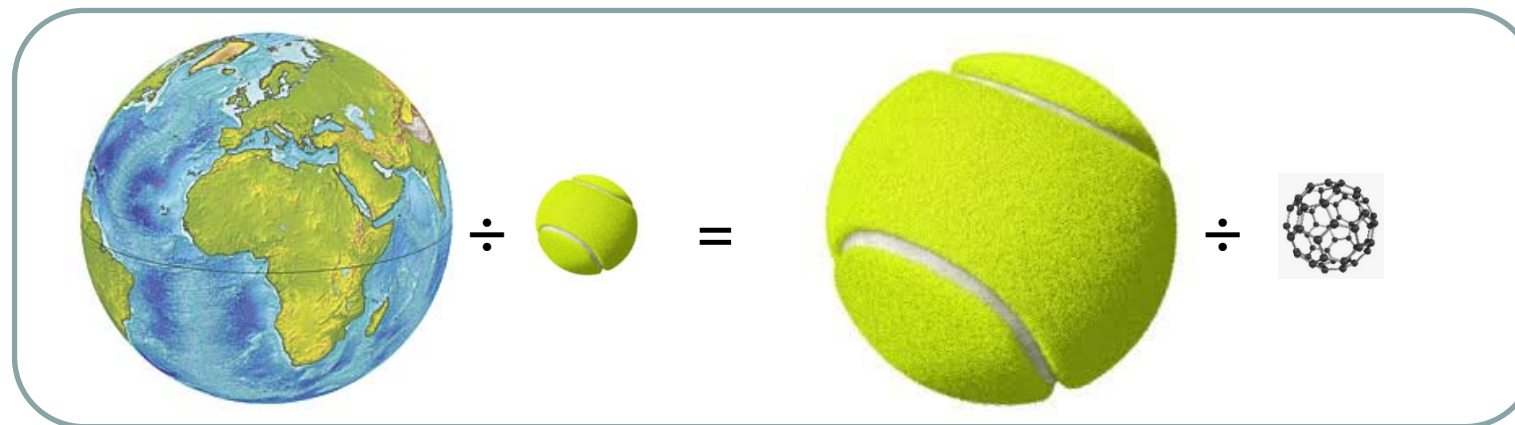
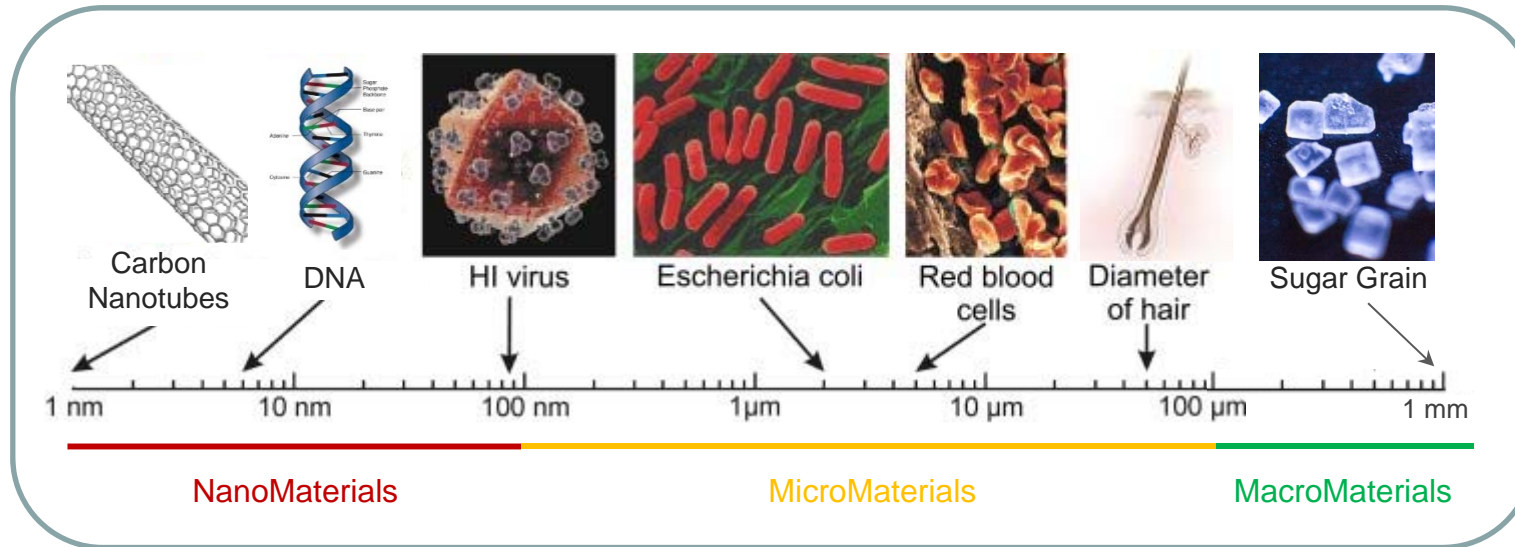
A scanning electron microscope (SEM) image showing a complex, interconnected network of nanofibers. The fibers are thin and appear to be randomly oriented, forming a dense, porous structure. The background is black, making the light-colored fibers stand out. The text is overlaid on the right side of the image.

NanoManufacturing

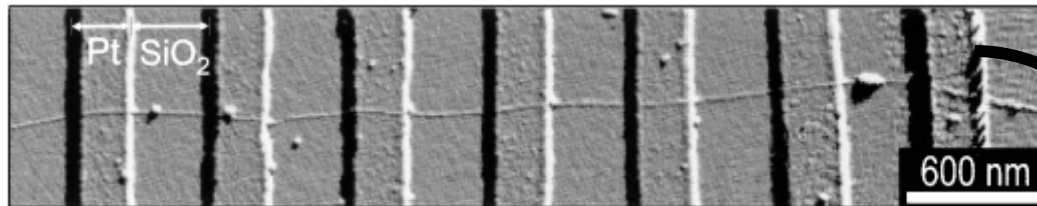
IfM Briefing Day

Michael De Volder

What are nanoparticles?

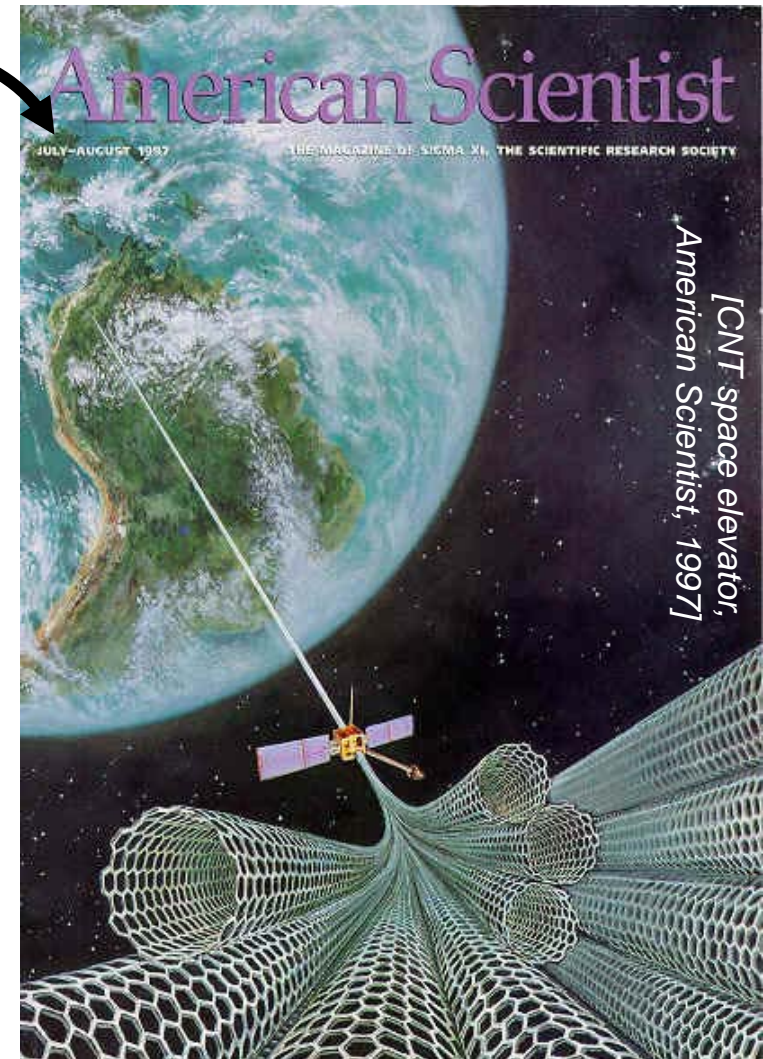


Why are CNT interesting? Nano hype?

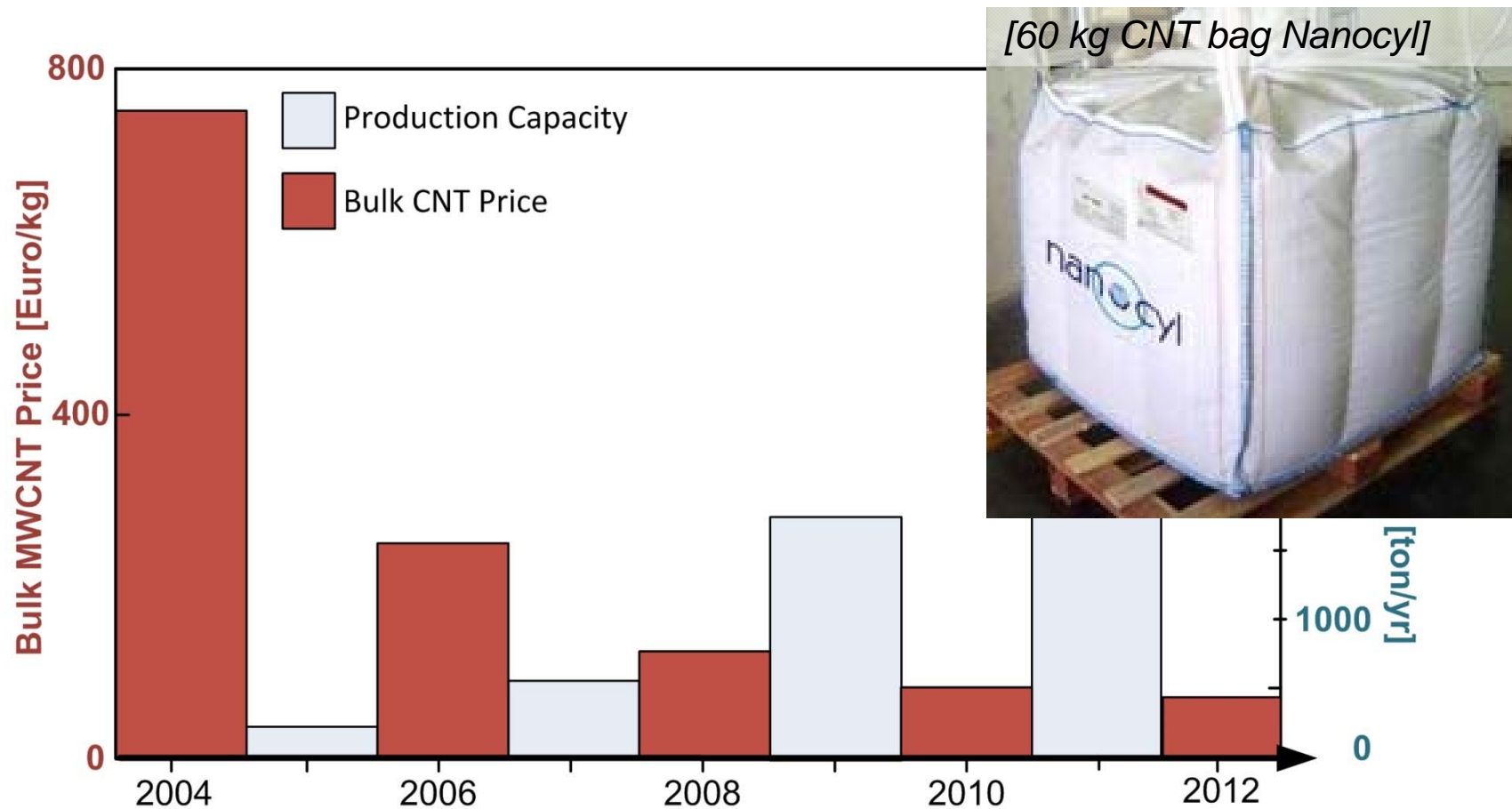


[Bezryadin et al., PRL, 1998]

- Young's modulus: 1 TPa
- Tensile strength: 100 GPa
- Current density 10^9 A/cm²
- Thermal conductivity: 3500 Wm⁻¹K⁻¹



CNT production volume and cost



[M. De Volder et al., Science, 2013]


Industrial Applications

Conductive Polymers



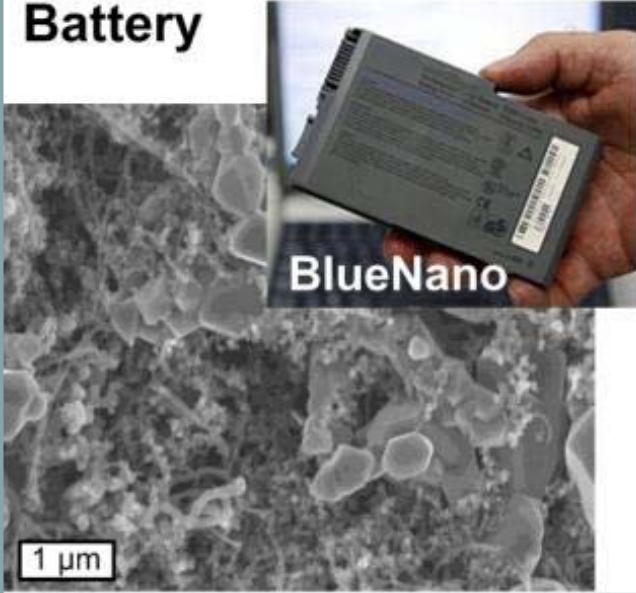
[Fuel tank, Nanocyl]

Structural Composites



[Zyvex]

Battery



BlueNano

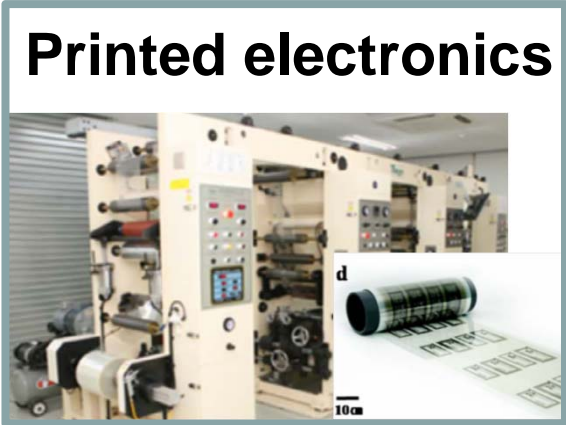
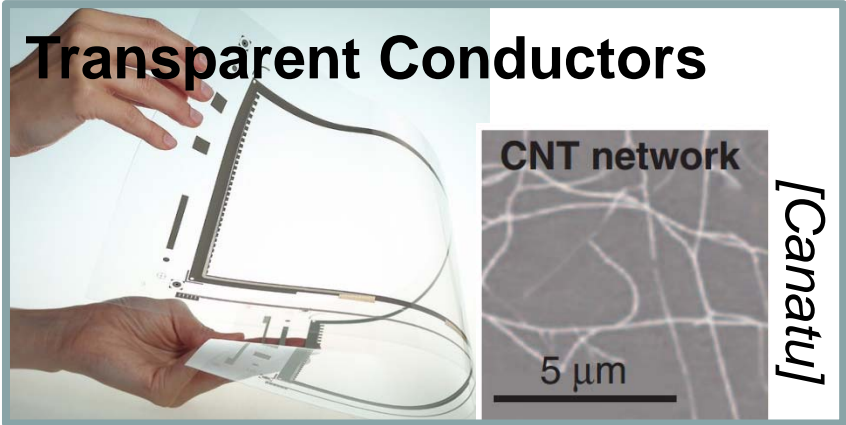
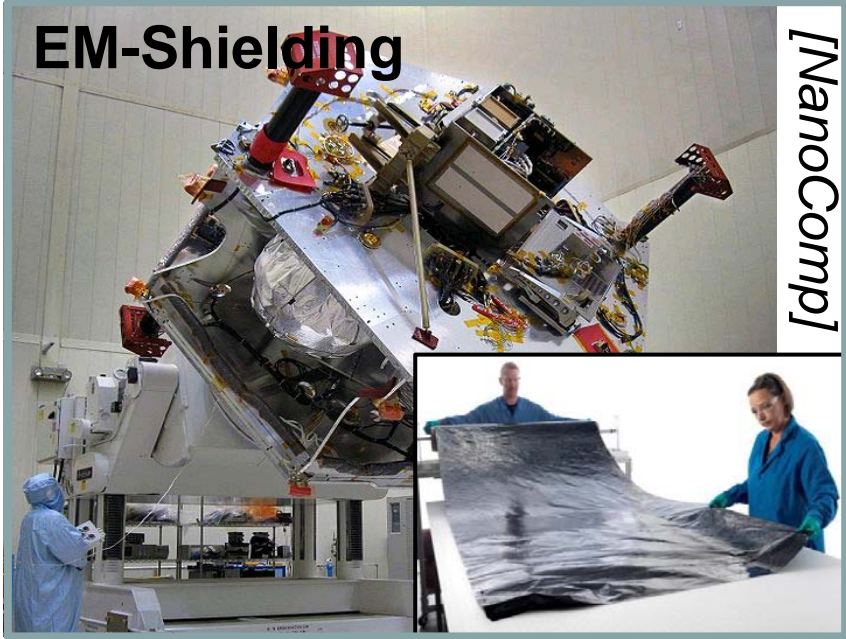
1 μm

Tires



[Occial]

Industrial Applications: Pure CNT products



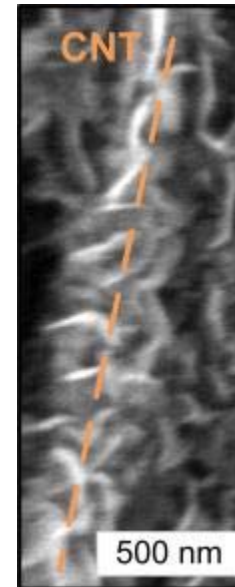
Nanoscale Modification

[M. De Volder, Unpublished]

Hydrothermal branching:



CVD deposition of graphene:



Solvothermal metal oxide decoration:



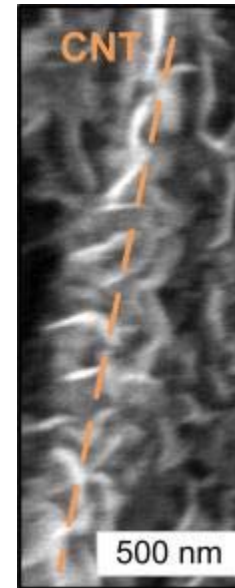
Nanoscale Modification

[M. De Volder, Unpublished]

Hydrothermal branching:



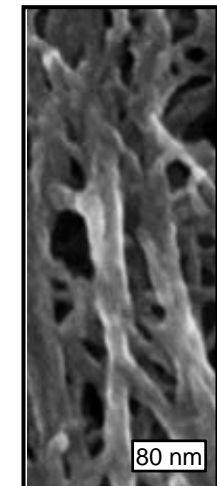
CVD deposition of graphene:



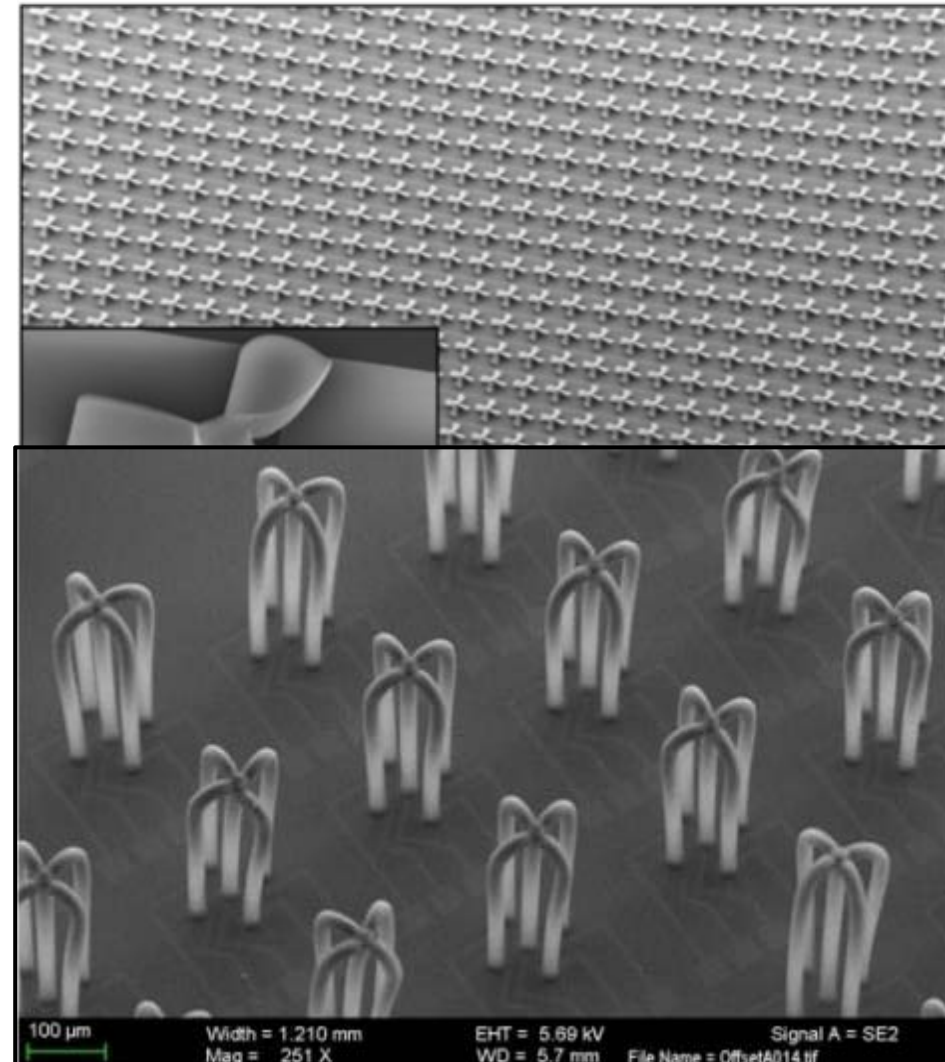
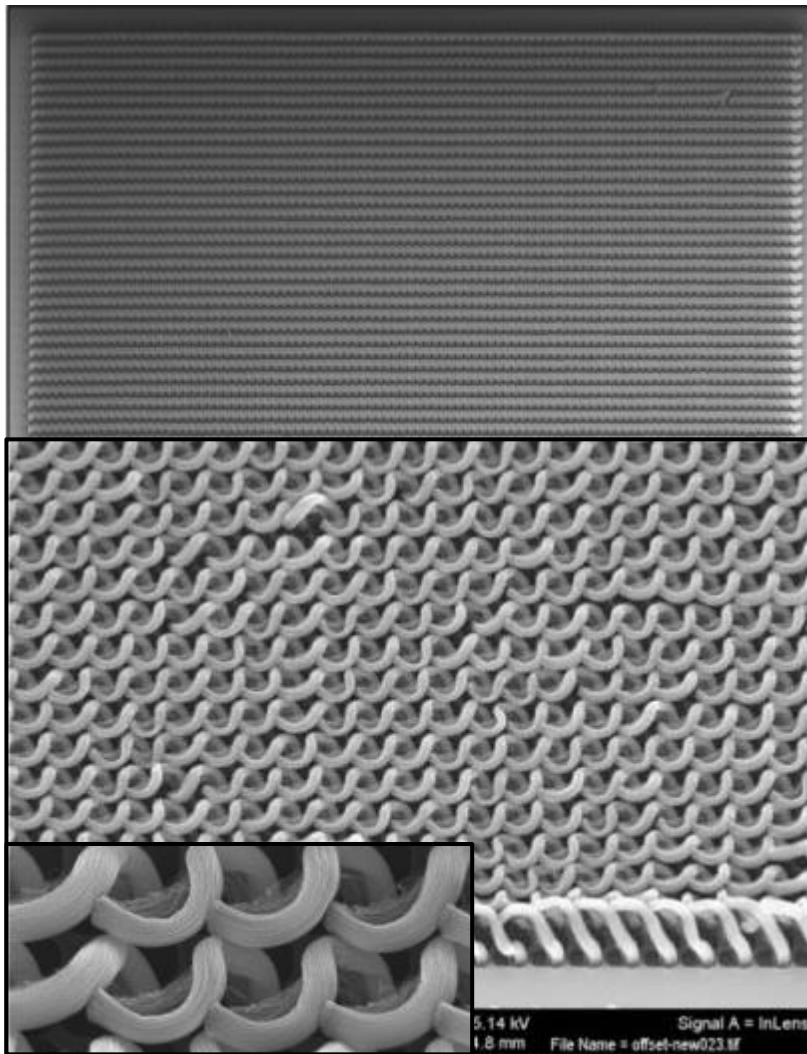
Solvothermal metal oxide decoration:



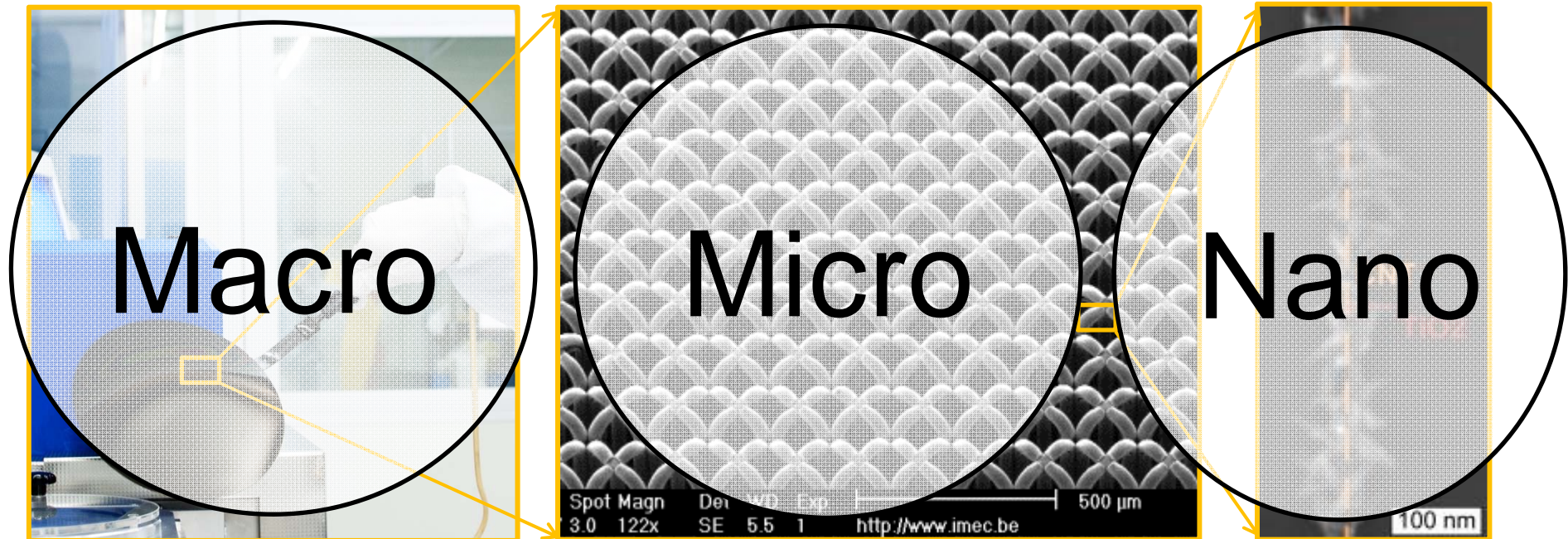
Atom Transfer Radical Polymerization:



Stress engineered CNT structuring



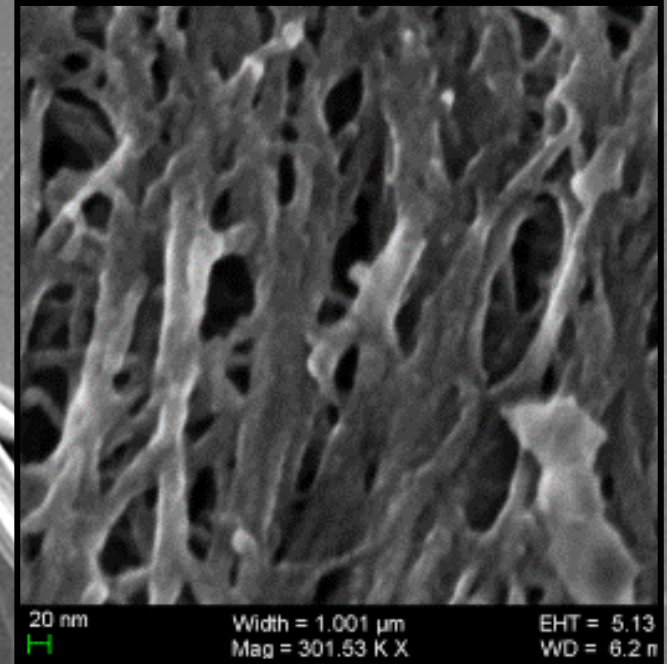
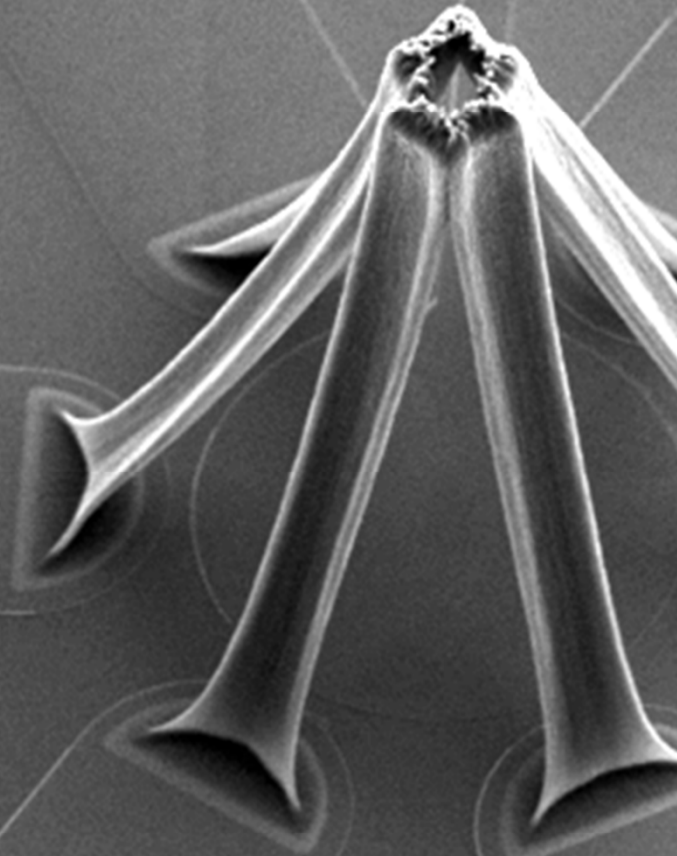
Overview top down approach



Applications:

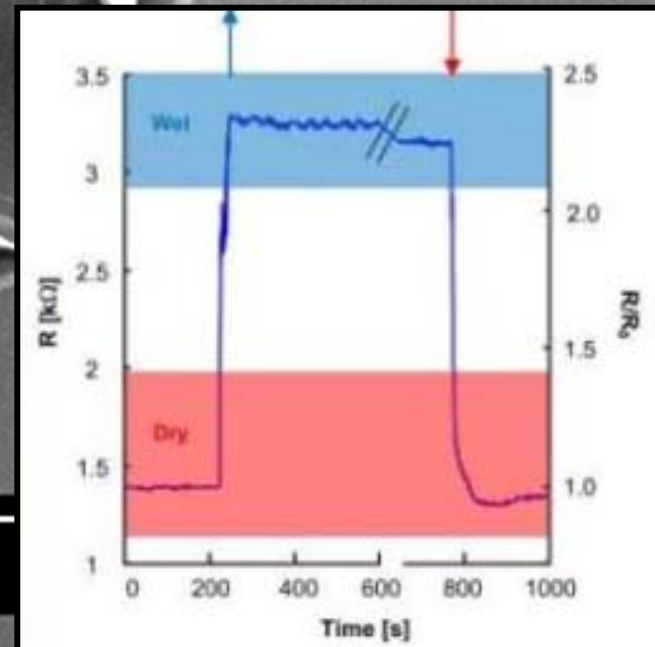
- MEMS
- Sensors
- Structural mechanics
- Energy Storage
- Catalysis

Applications: Sensors

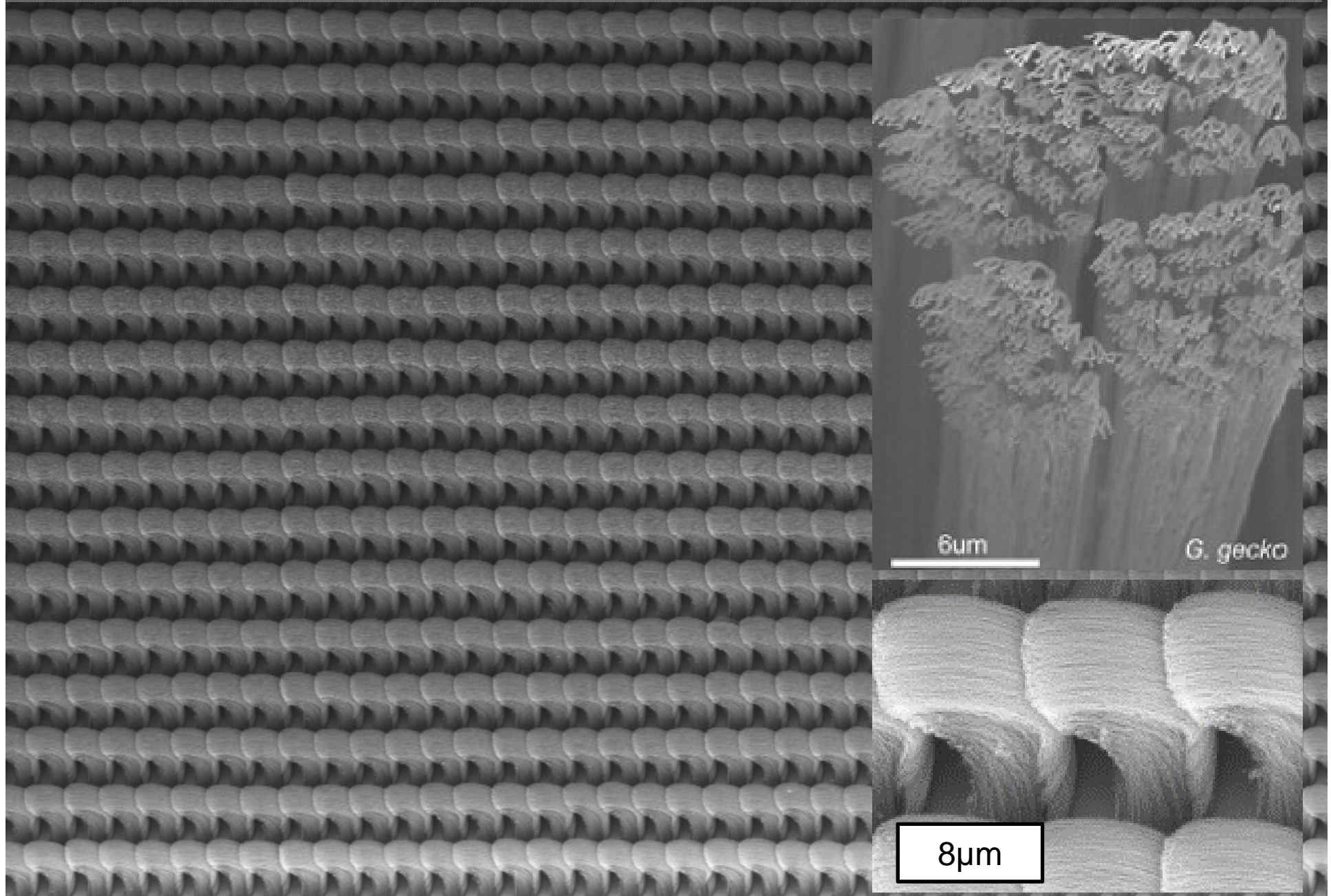


[M. De Volder, *Soft Matter*, 2011]

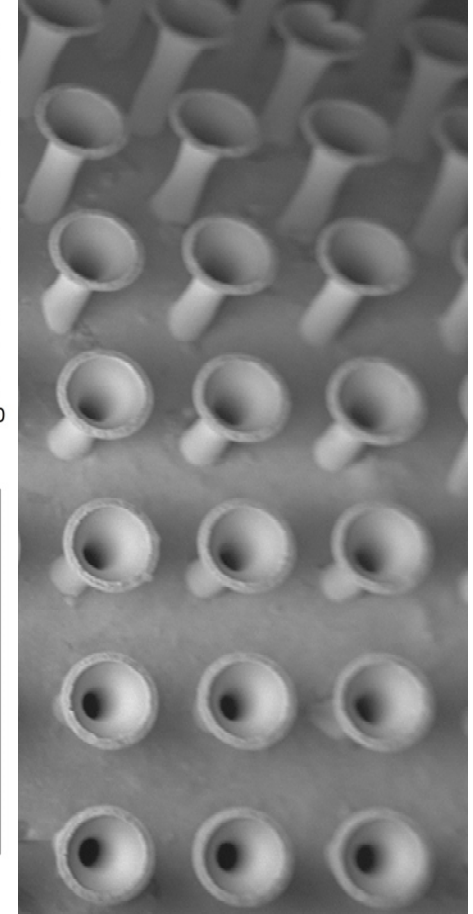
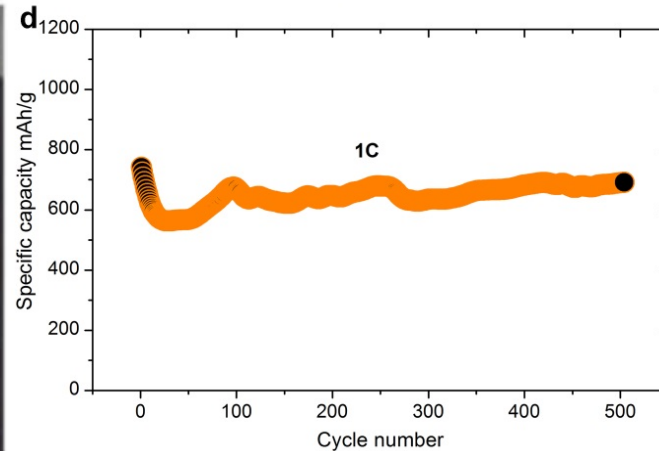
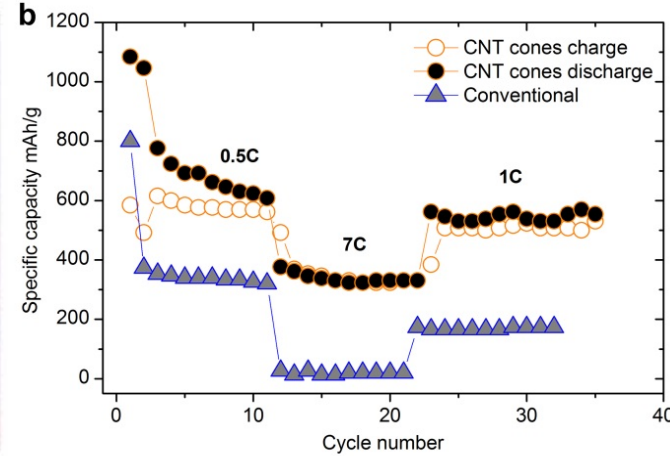
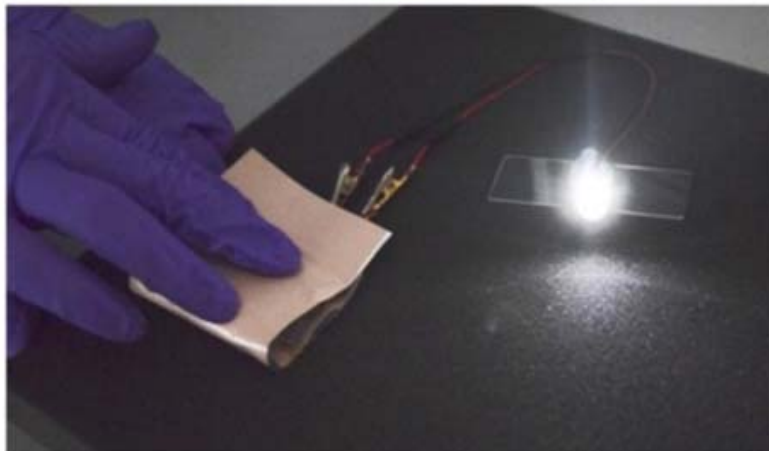
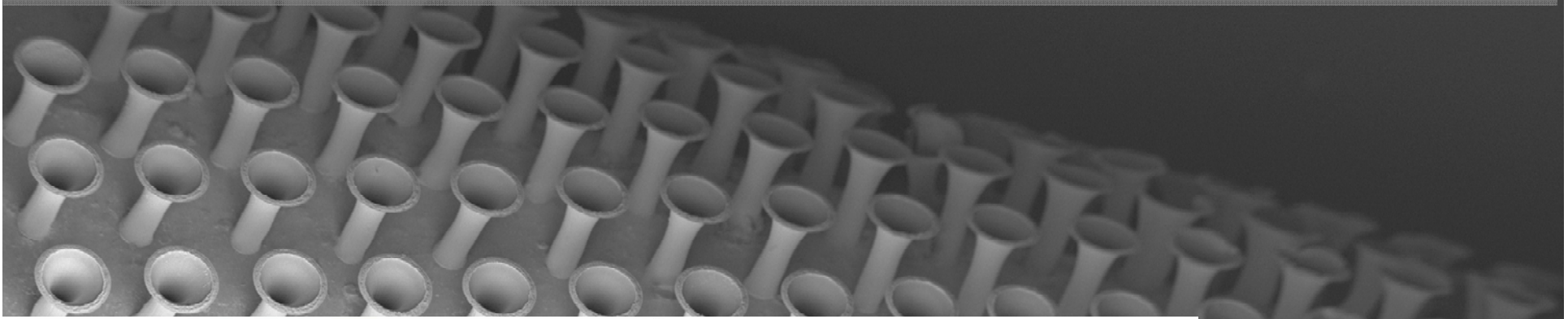
Acc.V	Spot	Magn	WD
5.00 kV	3.0	654x	8.7



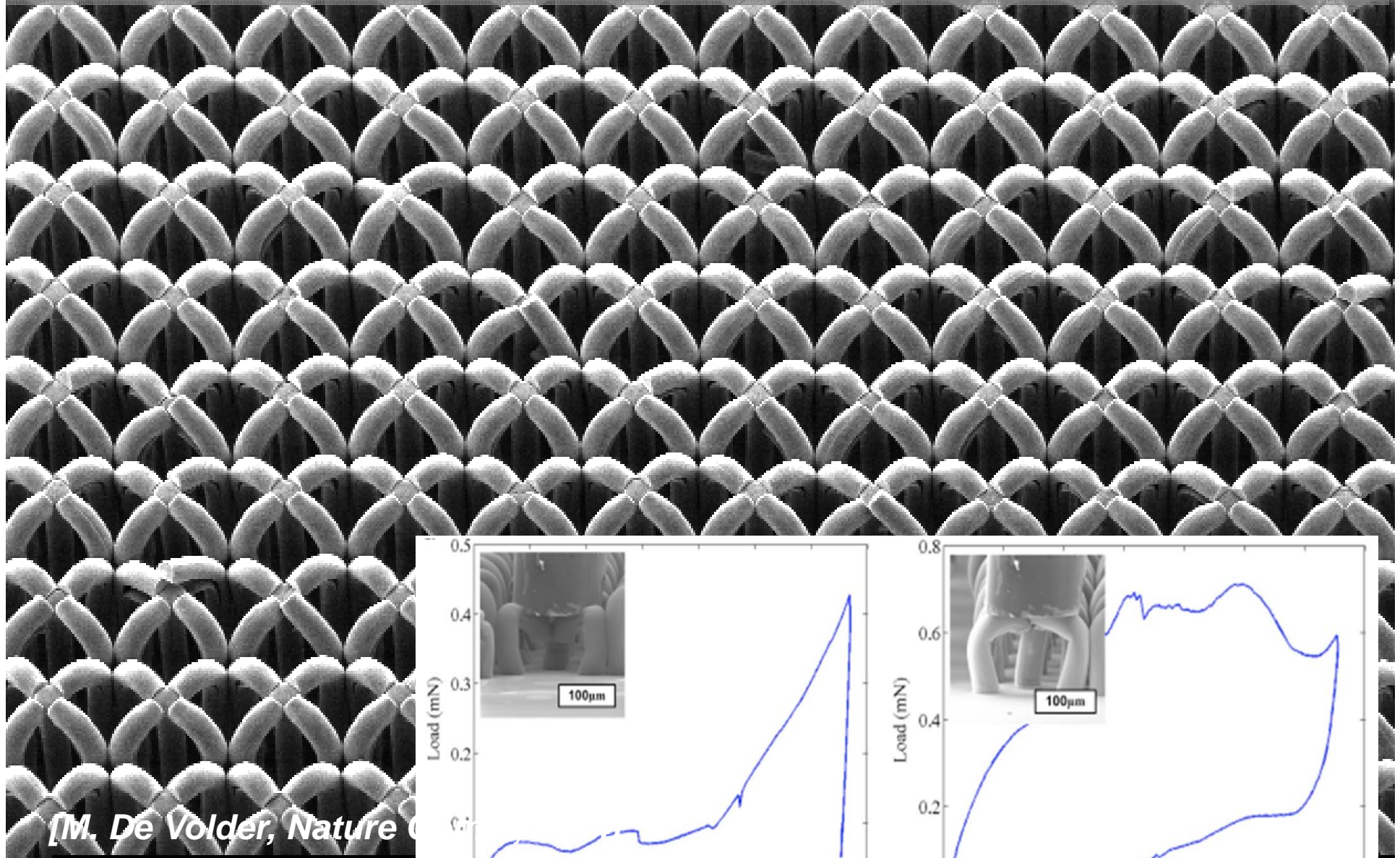
Applications: Anisotropic Adhesives



Future Directions: Flexible electrodes



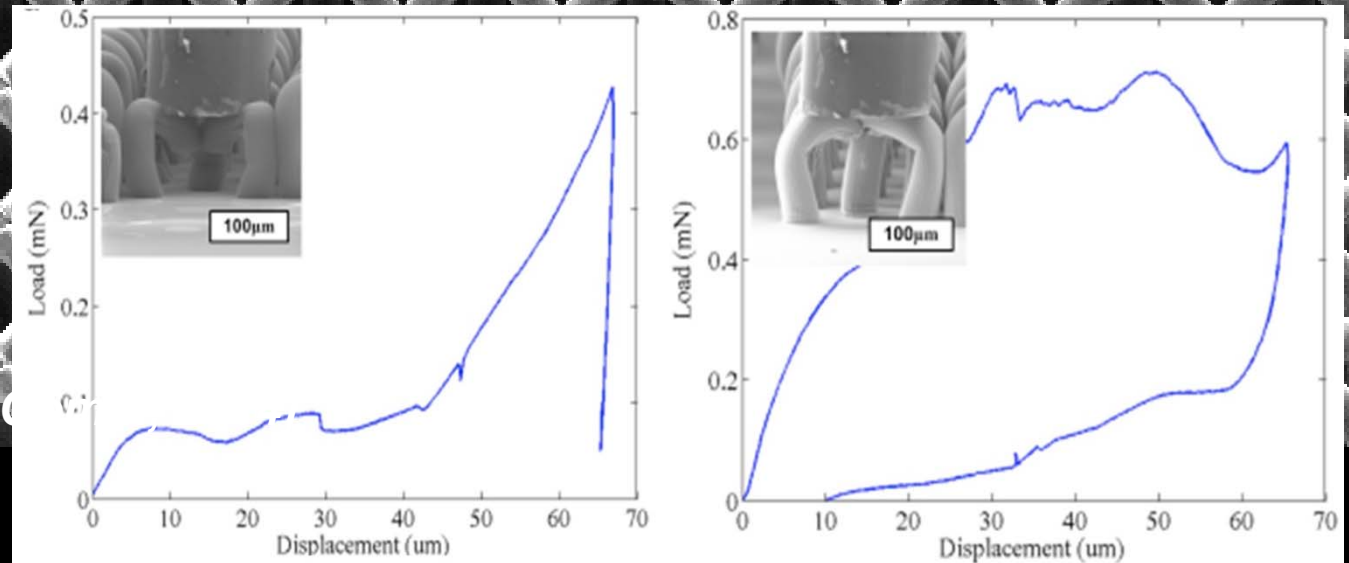
Applications: High Stiffness & Damping



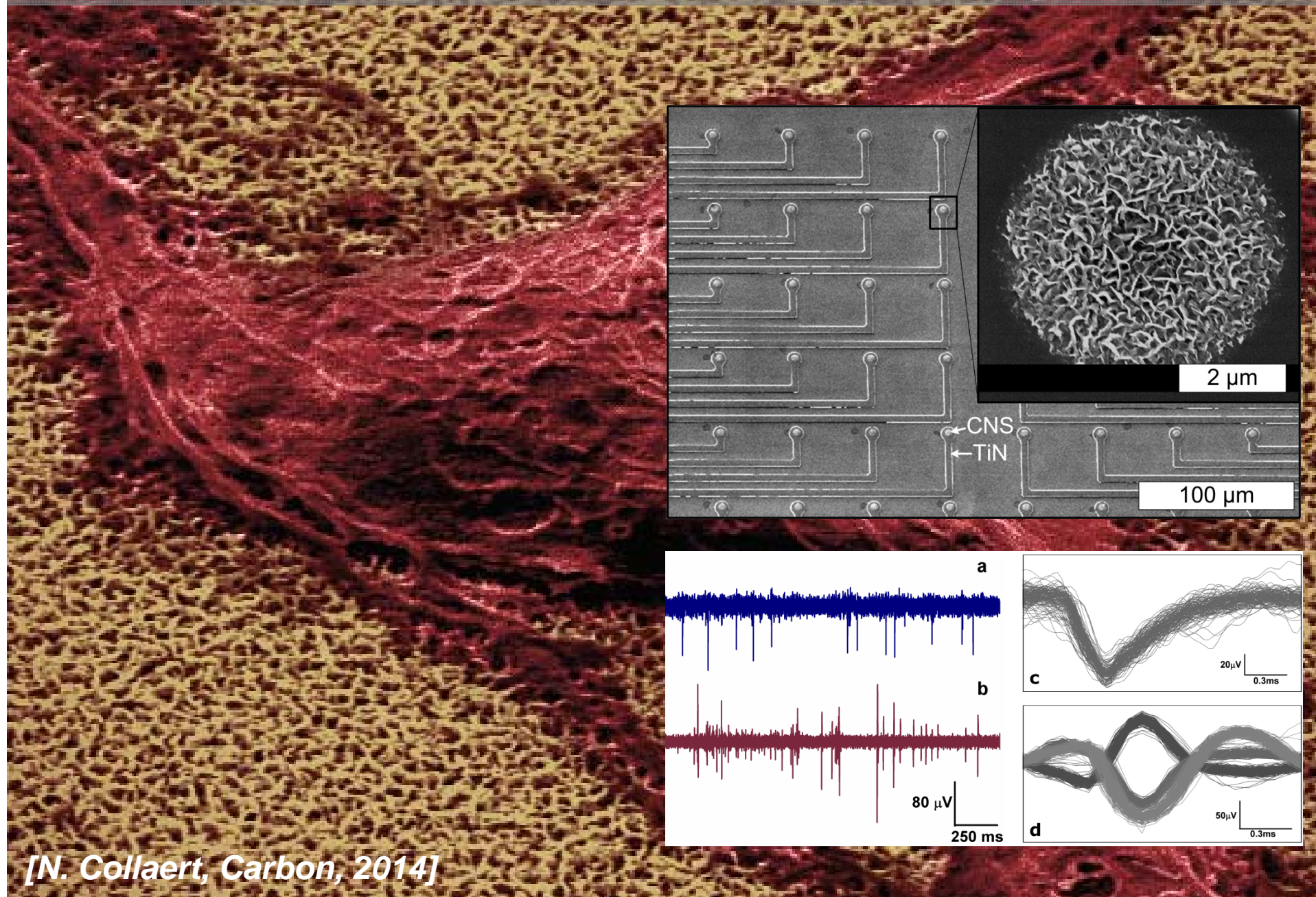
[M. De Volder, Nature

Acc.V Spot Magn

5.00 kV 3.0 122x

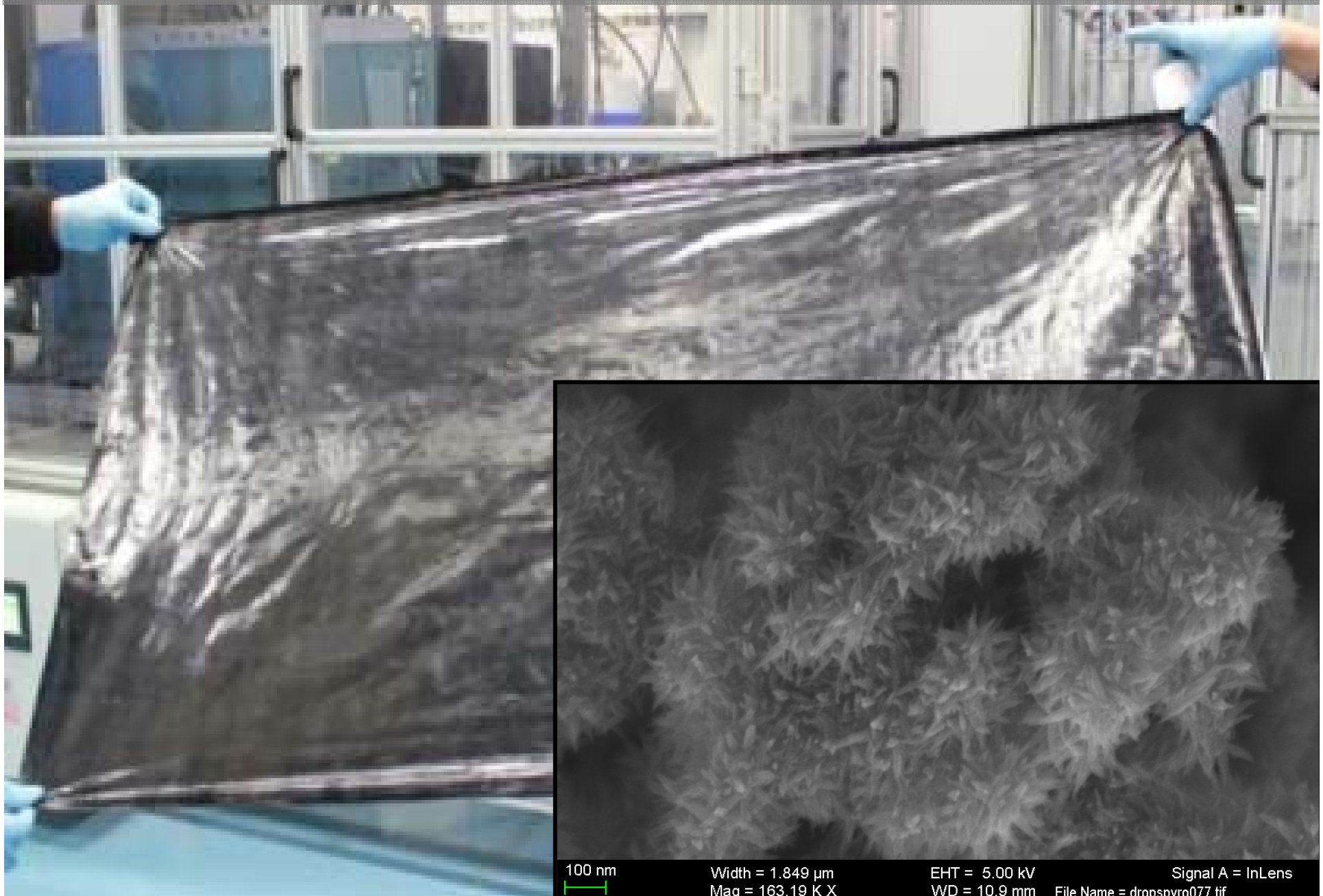


Applications: Biointerfaces

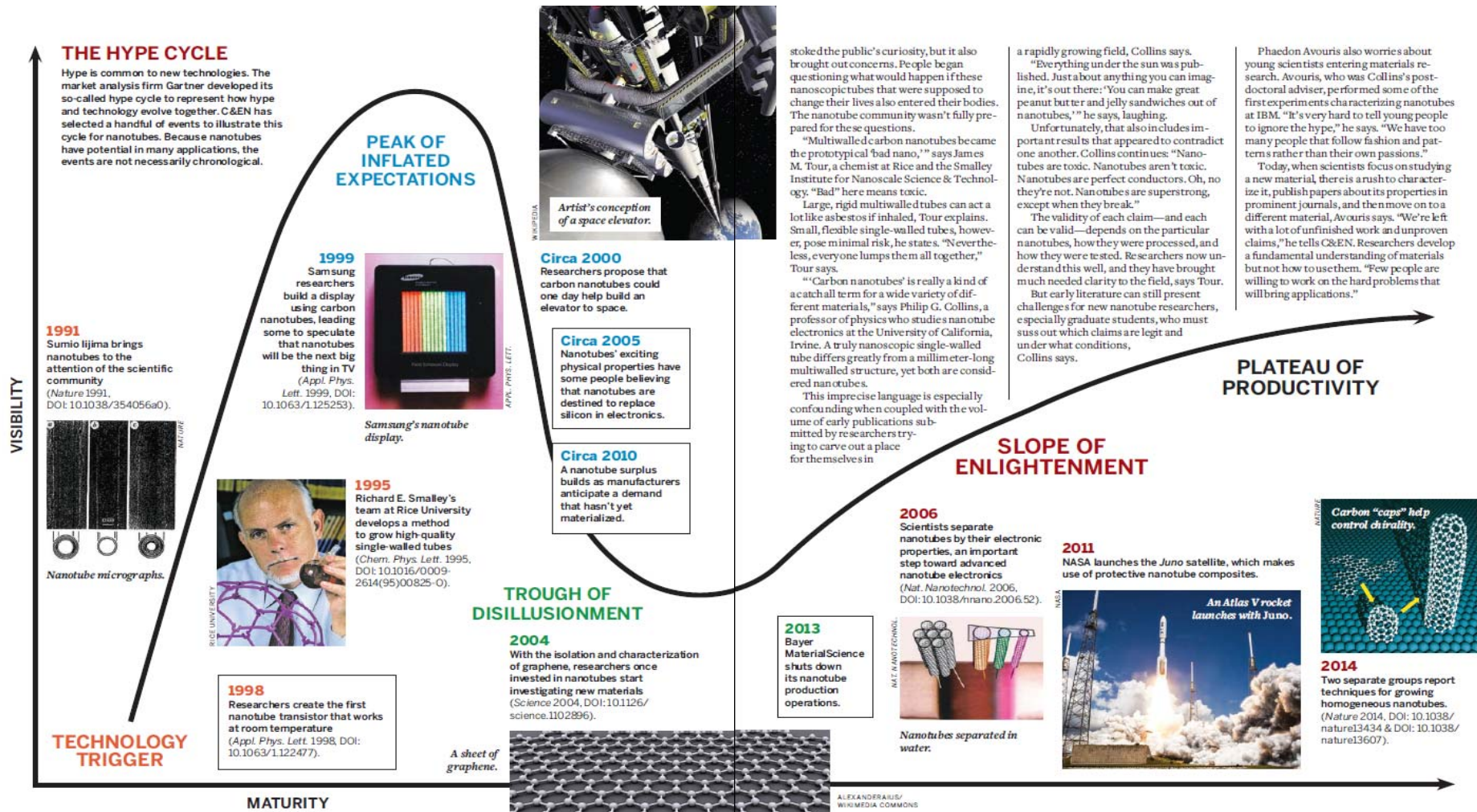


[N. Collaert, Carbon, 2014]

Applications: Energy Storage



CNTs Hype Cycle



The NanoManufacturing Team:



Dr. C. George



Dr. D. Copic



Dr. S. Ahmad



Dr. D. Beesley



Dr. N. Chiodarelli



Dr. L. Maggini



Dr. M. Golozar



Dr. C. Messner



H. Modarres



S. Jessl



J. De La Verpilliere



S. Engelke



L. Van Den Broeck

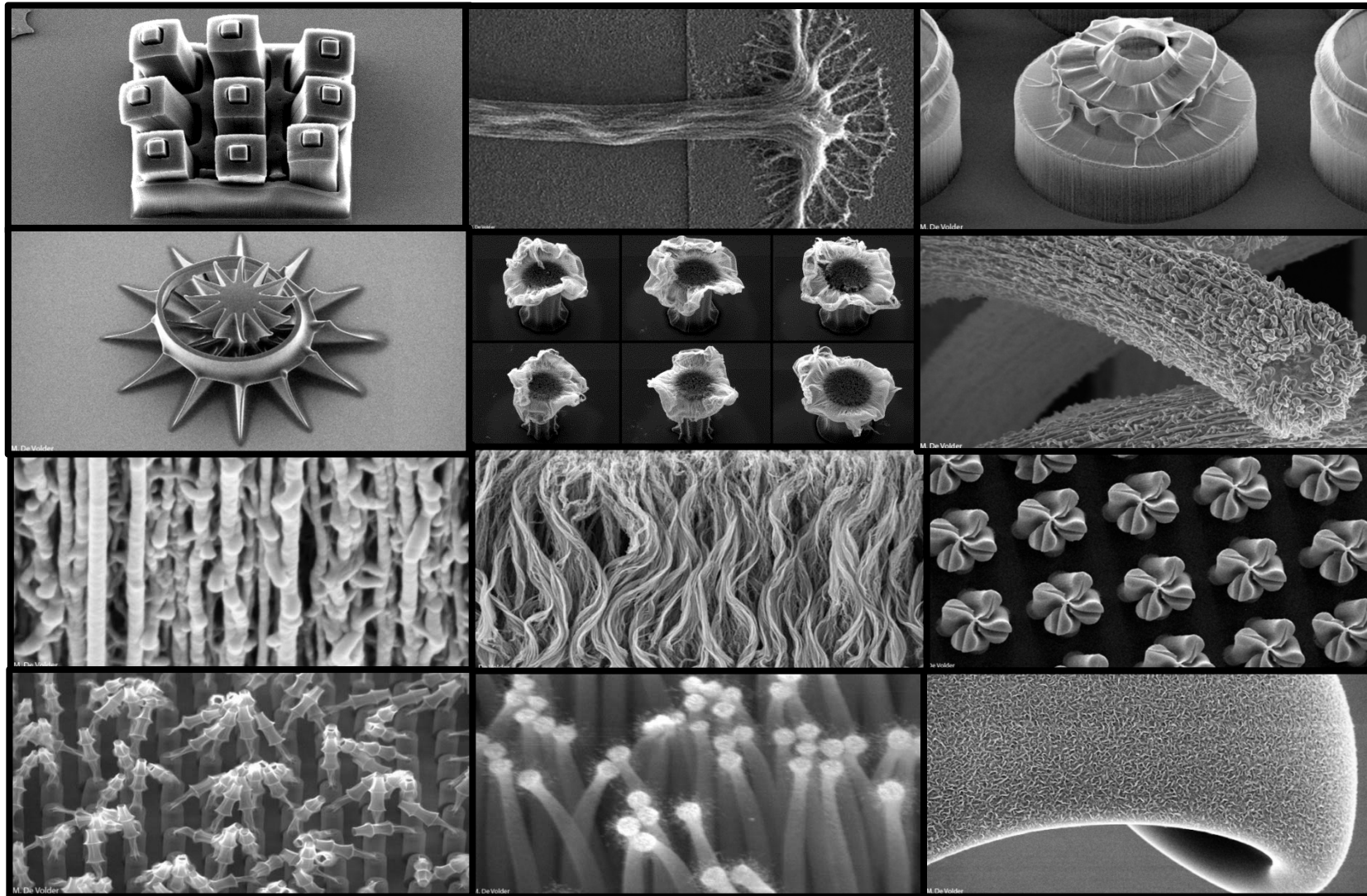


L. Nucara

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Contact: *mfld2@cam.ac.uk*

Thank you



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*ERC, EPSRC, Marie Curie, FWO, Isaac Newton Trust,
Belspo, Royal Society*

mfld2 @cam.ac.uk

