



Nanomaterials: Not Just Manufacturing

James R. Von Ehr
CEO



- Privately held company; Founded in 1997
- Located in Richardson, Texas
- Five-Year Strategic Business and Marketing plans
- Detailed Technology Roadmap
- Aggressive IP strategy
- Extensive list of scientific and business publications
- International scale

- Headcount: 58 and increasing
 - 15 Ph.D.s
 - Engineers, scientists, technical management
- 22 patents, 40 more in works
- 44,000 sq. ft. facility
- Class 1000 clean room
- Several fully equipped laboratories
- CNC-equipped machine shop
- Equipment: SEM, TEM, AFM, SPM, UHV-STM, MEMS motion analyzer, electrical testing station

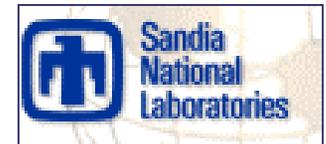


Customers

Partial List



massachusetts institute of technology

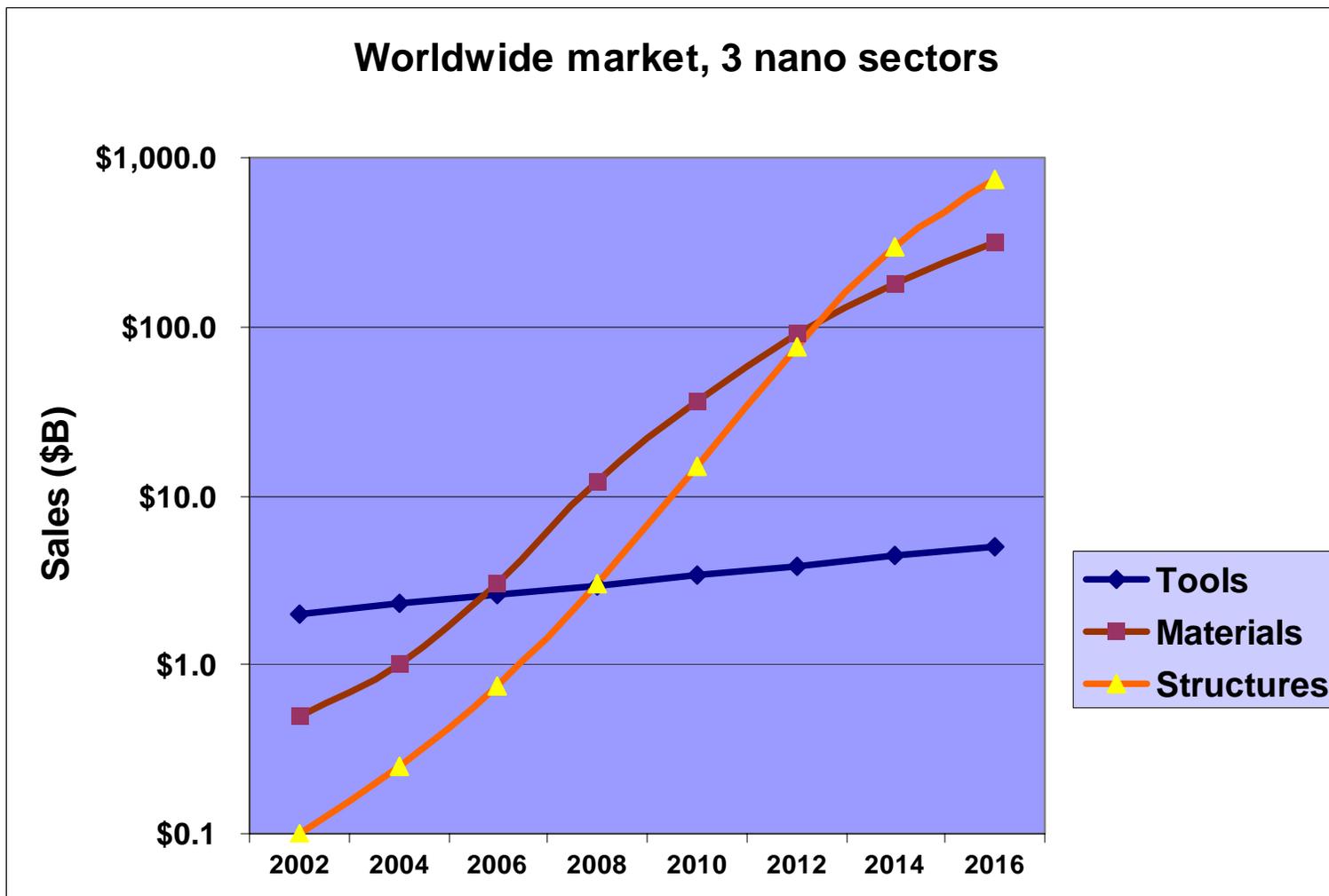




Vision

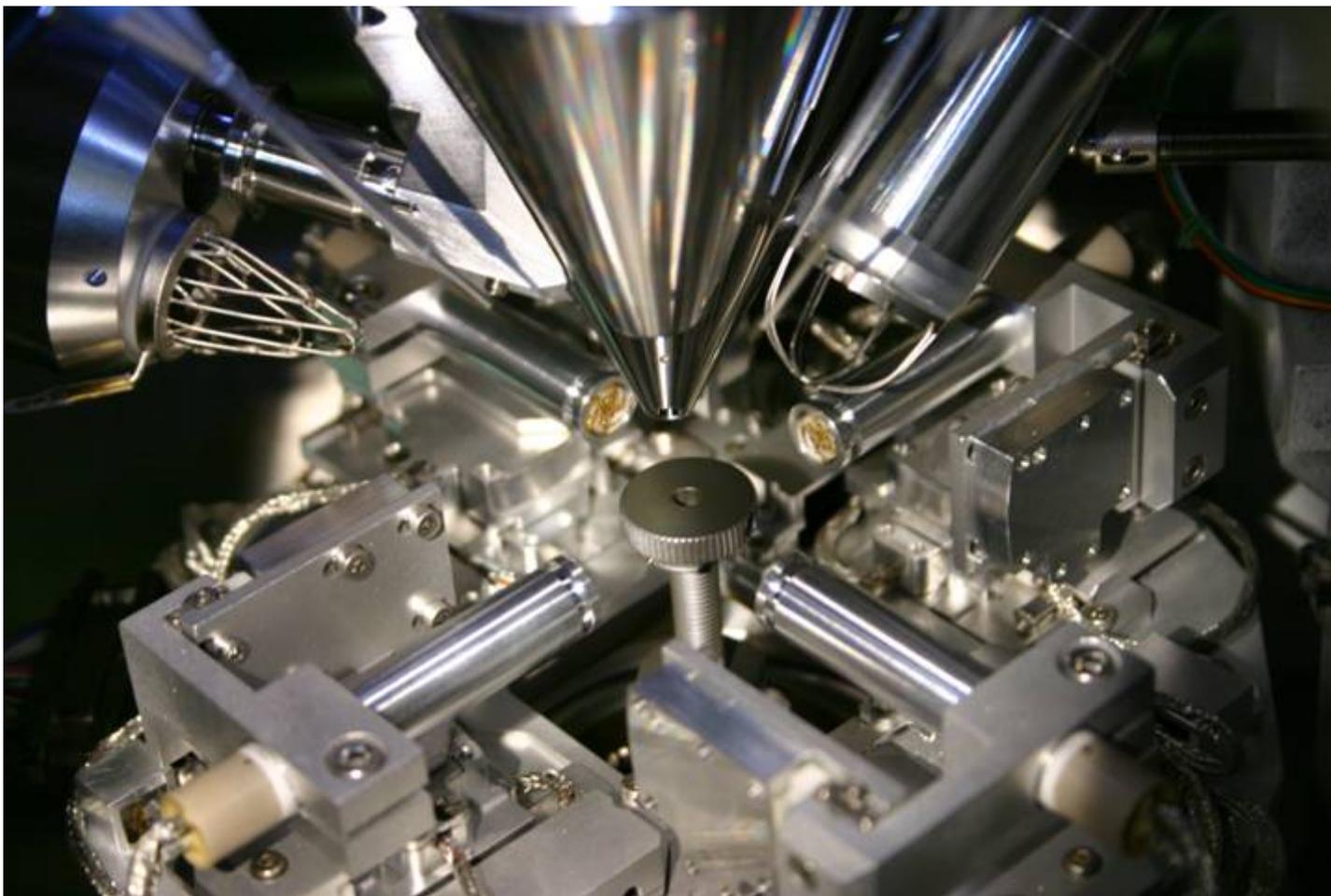
Our vision is to be the leading worldwide supplier of tools, products, and services that enable adaptable, affordable, and molecularly precise manufacturing.

We are taking an assembly-based approach to integrating across all length scales from macro to micro to nano.

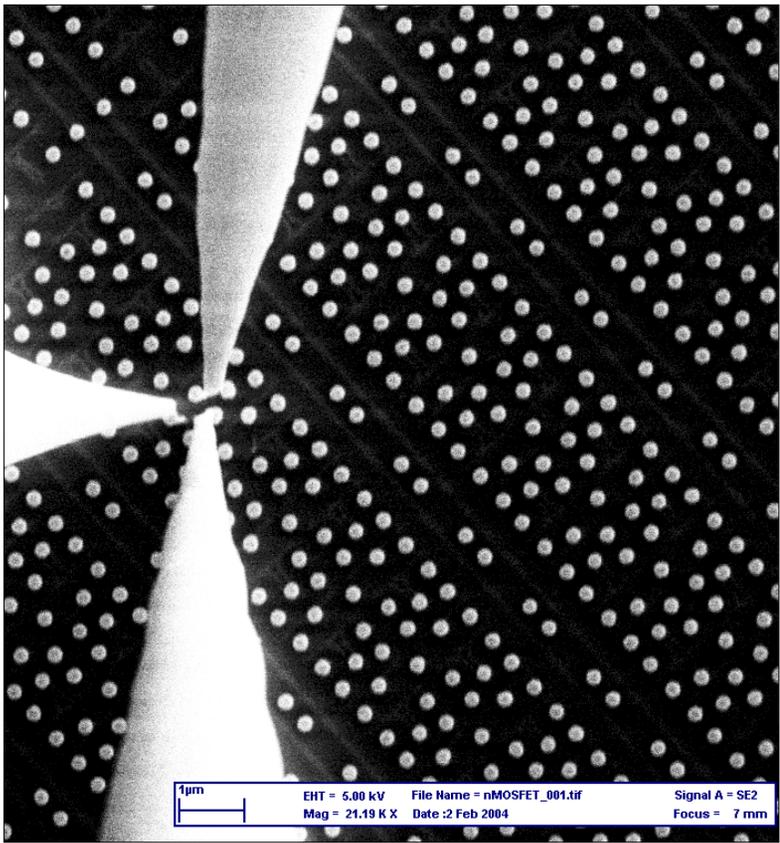




The Zyvex Approach: NanoWorks™ Tools

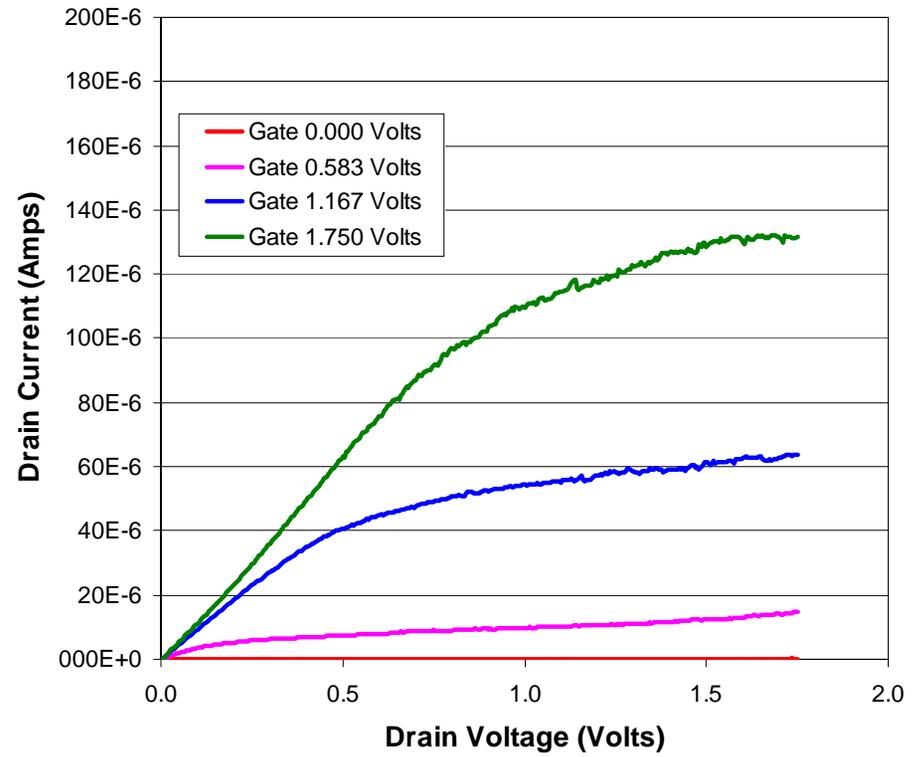


Probing Solution



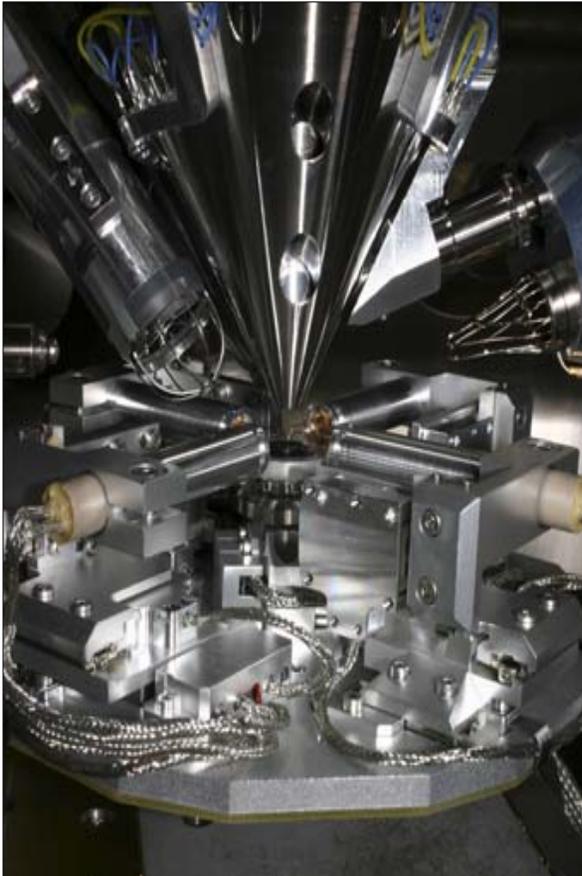
Land on contacts <100nm diameter

Forward Biased nChannel FET



IV curve of n-type MOS-FET

S100 Nanomanipulator Family



S100: Scanning Electron Microscopes

F100: Focused Ion Beam systems

A100: Ambient (optical microscopes)

**L100: Life Sciences model
(biomanipulation)**

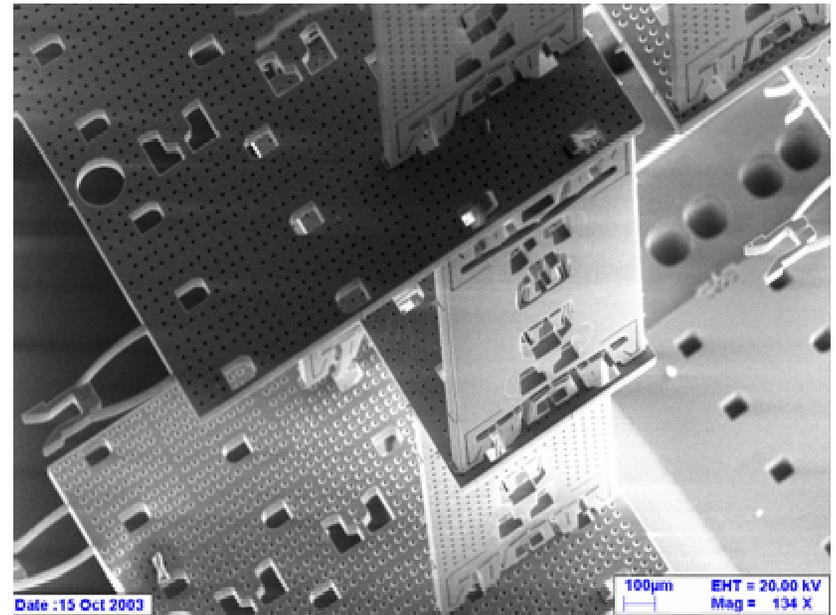
**KZ100: IC probing solution (with
Keithley Instruments)**

Tweezers, Nanosharp[™] probes

tDriver Station

mDriver Station

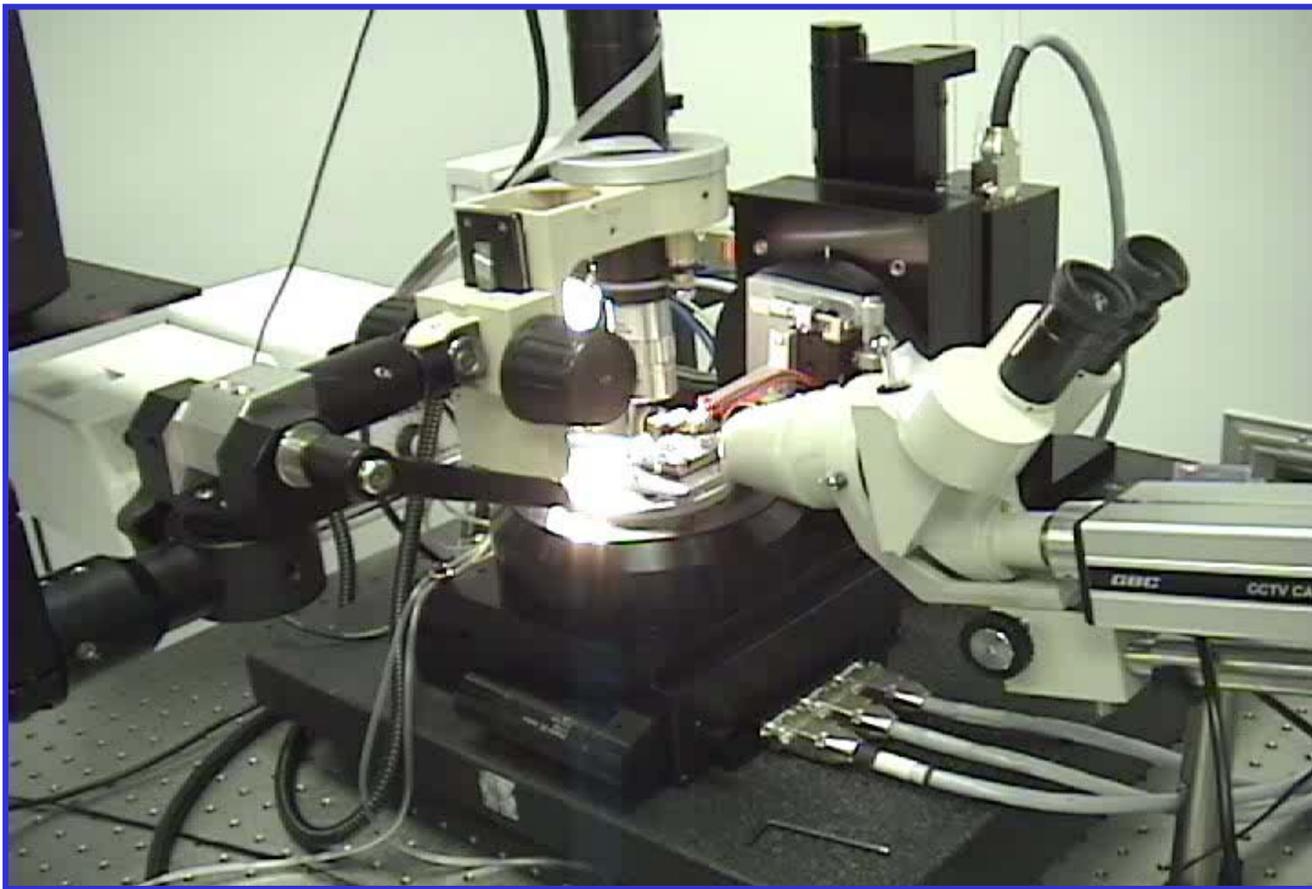
pDriver Station



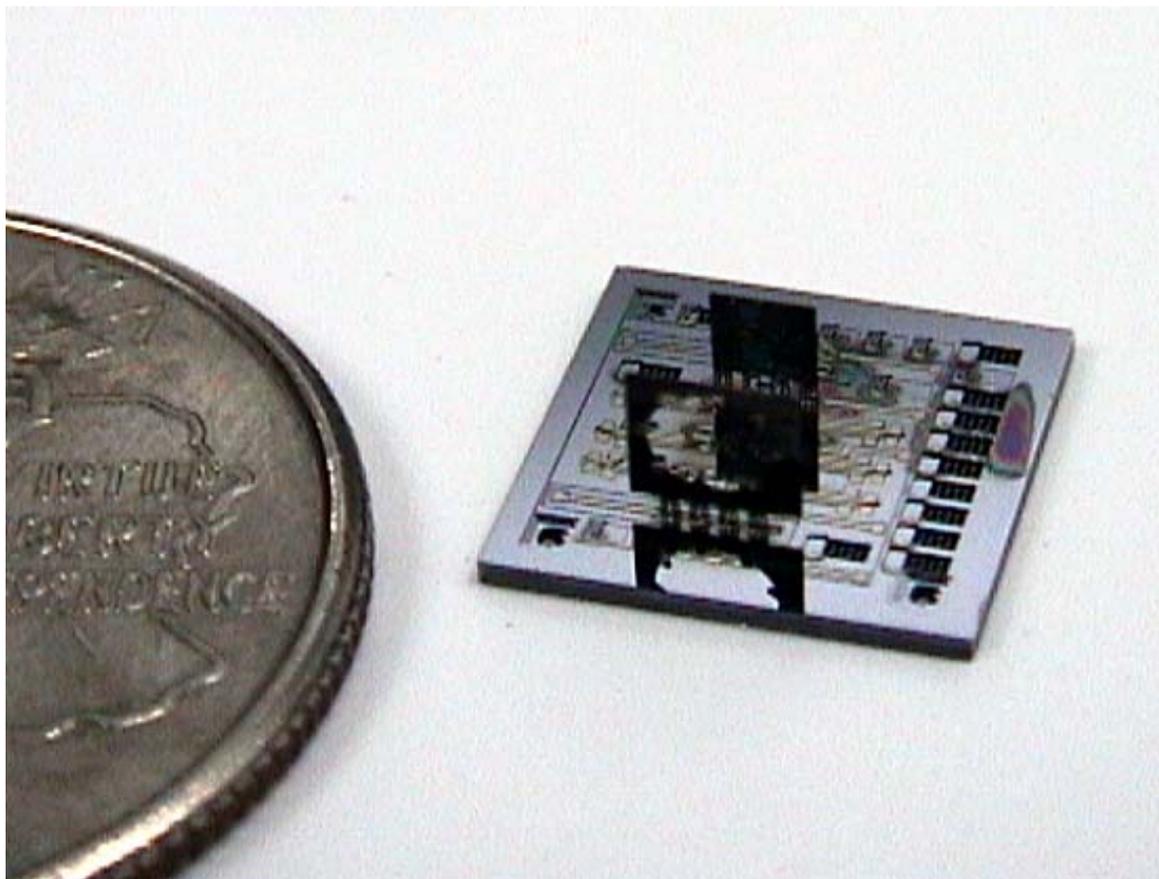
Heterogeneous Assembly

(Tool Building: The Next Generation)

Assembly demonstration



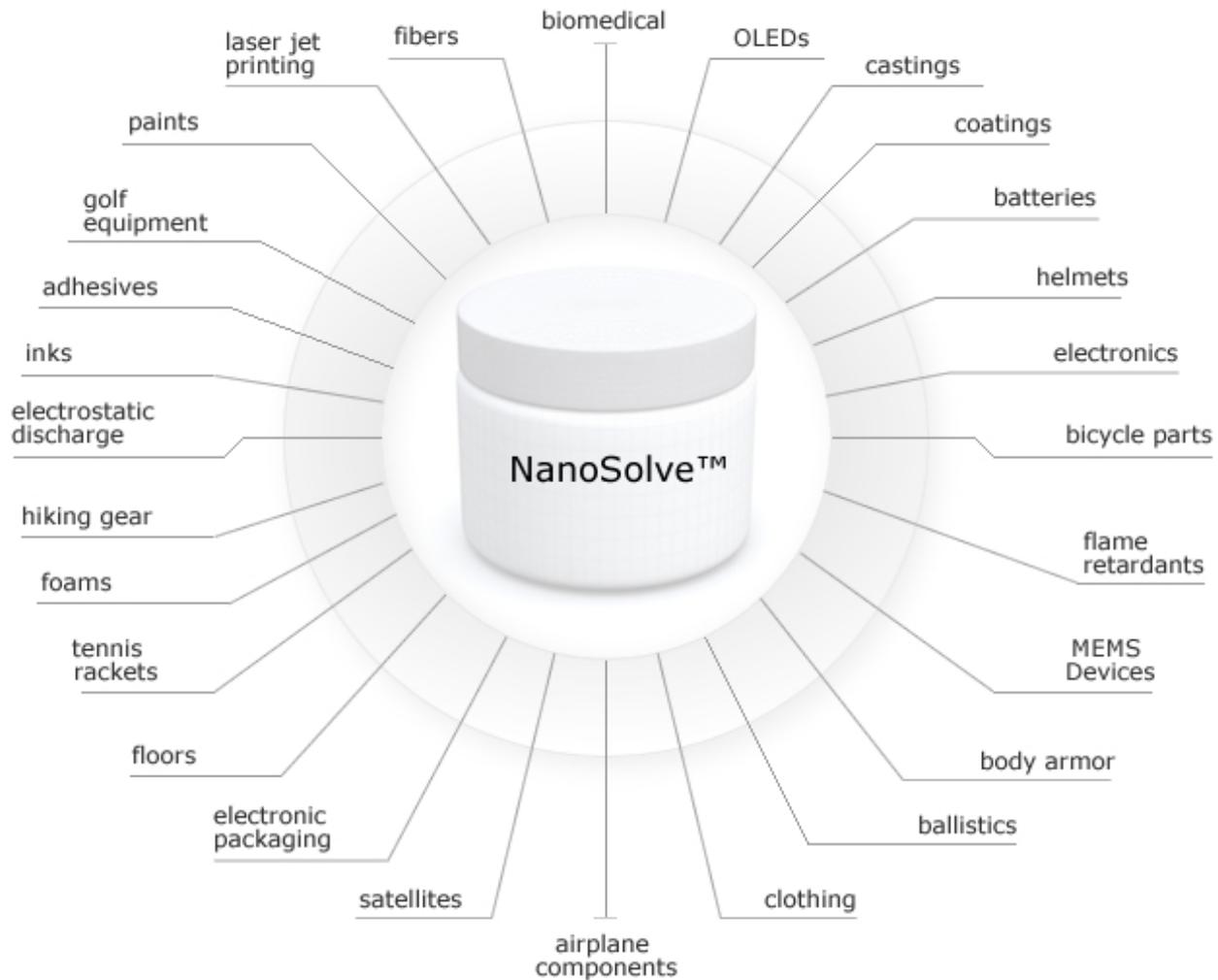
Assembled Microcolumn Components





The Zyvex Approach: NanoSolve[™] Materials

Materials Applications







Nanomaterials roadblocks

- **Availability**
- **Functionality**
- **Processing into products**
- **Cost (and cost/performance)**

- **Scale-up manufacturing process**
- **Consistency & quality (QC)**



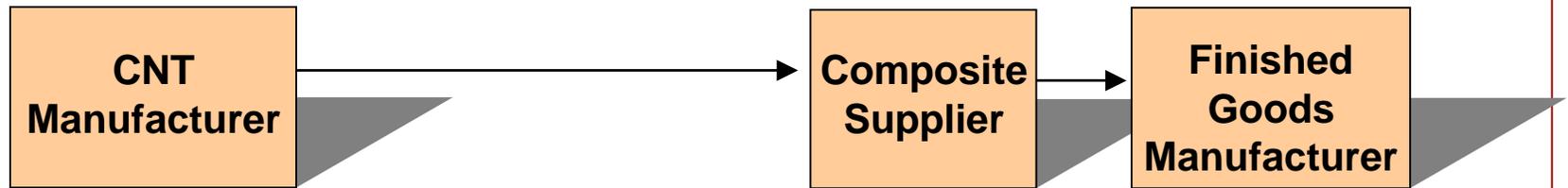
Customer care-about

- **Cheaper (cost, cost-effectiveness)**
- **Better (quality, performance)**
- **Easy to use**
- **Compatible**
- **Safe**

- **Materials developer (research)**
- **Materials manufacturer**
- **Formulator**
- **End user**

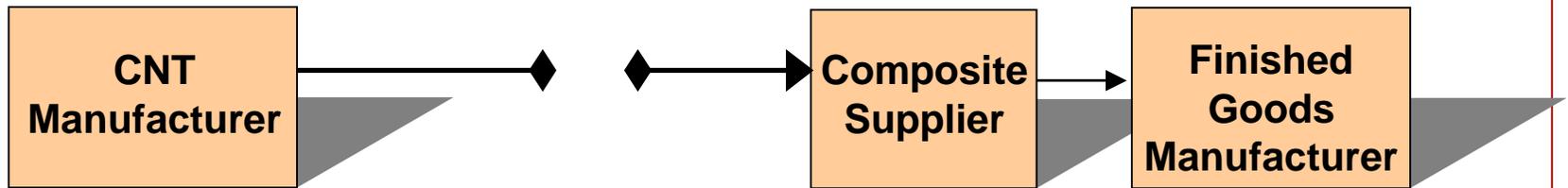
- **Supply chain manager**
 - Help customer buy correct product, use it
 - Leverage proprietary technology:
dispersion, processing recipes

Perceived Supply Chain



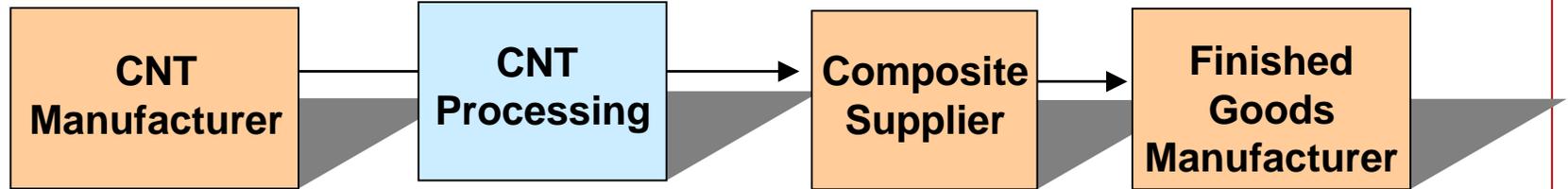
If CNTs were simple materials coming from an established manufacturer, then they could be drop-in components into an existing formulation.

Actual Supply Chain



Raw nanotubes aggregate and cannot be dispersed in a host polymer.

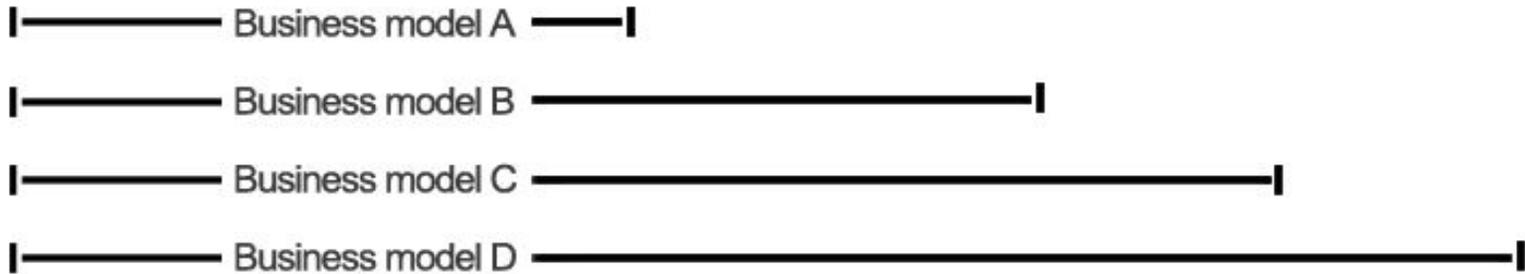
Actual Supply Chain



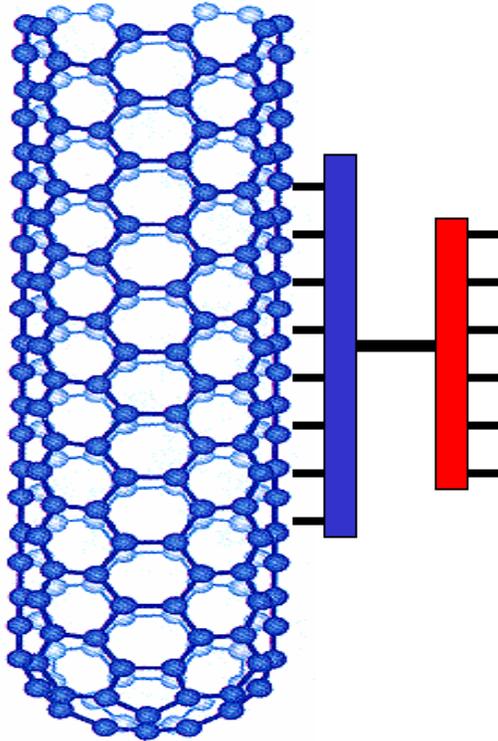
Raw nanotubes aggregate and cannot be dispersed in a host polymer.

Zyvex's Kentera[™] technology fixes this problem.

NanoSolve™ Value Chain

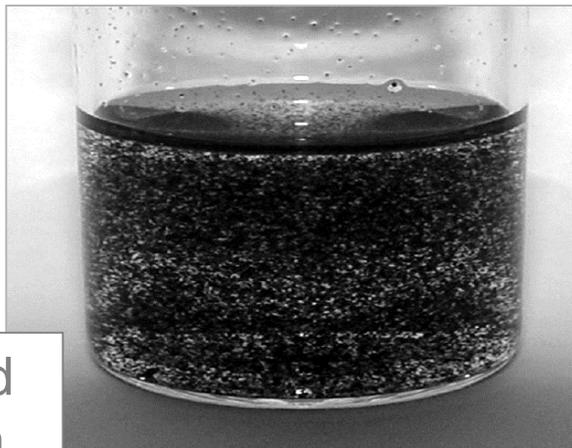


Zyvex's CNT Technology

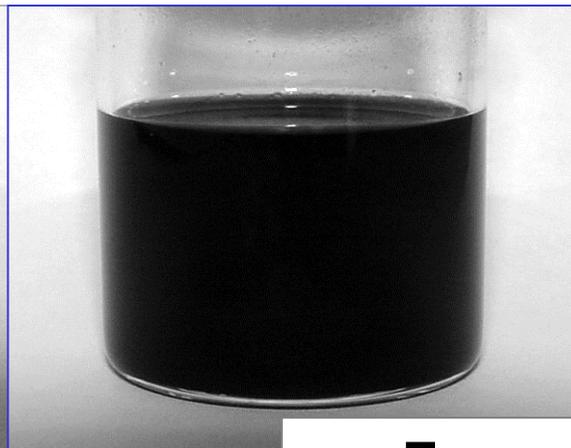


- **Two distinct functions:**
 - Non-damaging binding to CNT
 - Side-chain engineering
- **Binding applicable to SWNTs, MWNTs and other nanostructures**
- **Engineered for different uses:**
 - Solubility in organic solvents
 - Adhesion to composite matrix
 - Solubility in water
 - Sensor applications
 - Other chemical functionality

Poor vs. Good Dispersion/PU

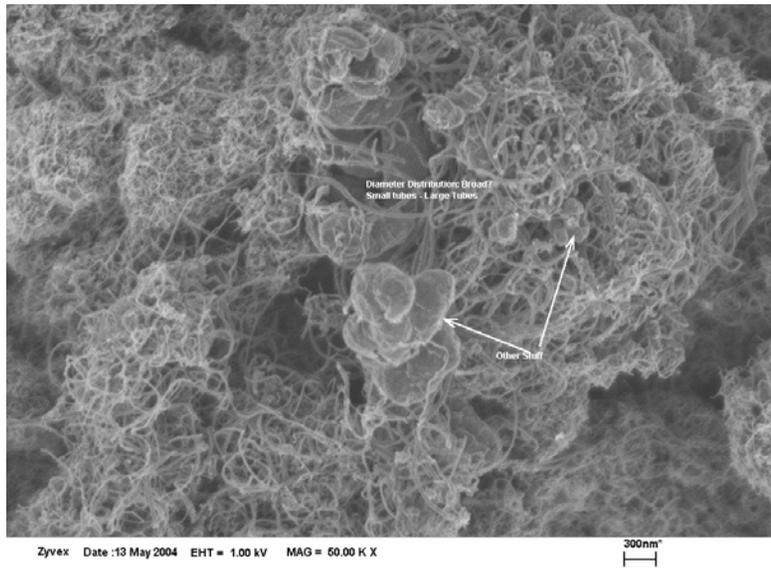


Unprocessed
nanotubes in
liquid

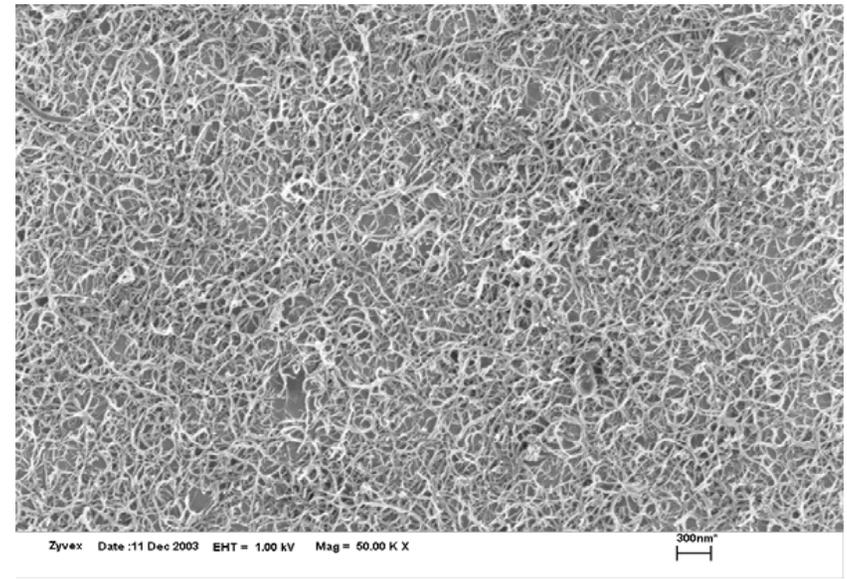


**Zyvex processed
nanotubes in liquid**





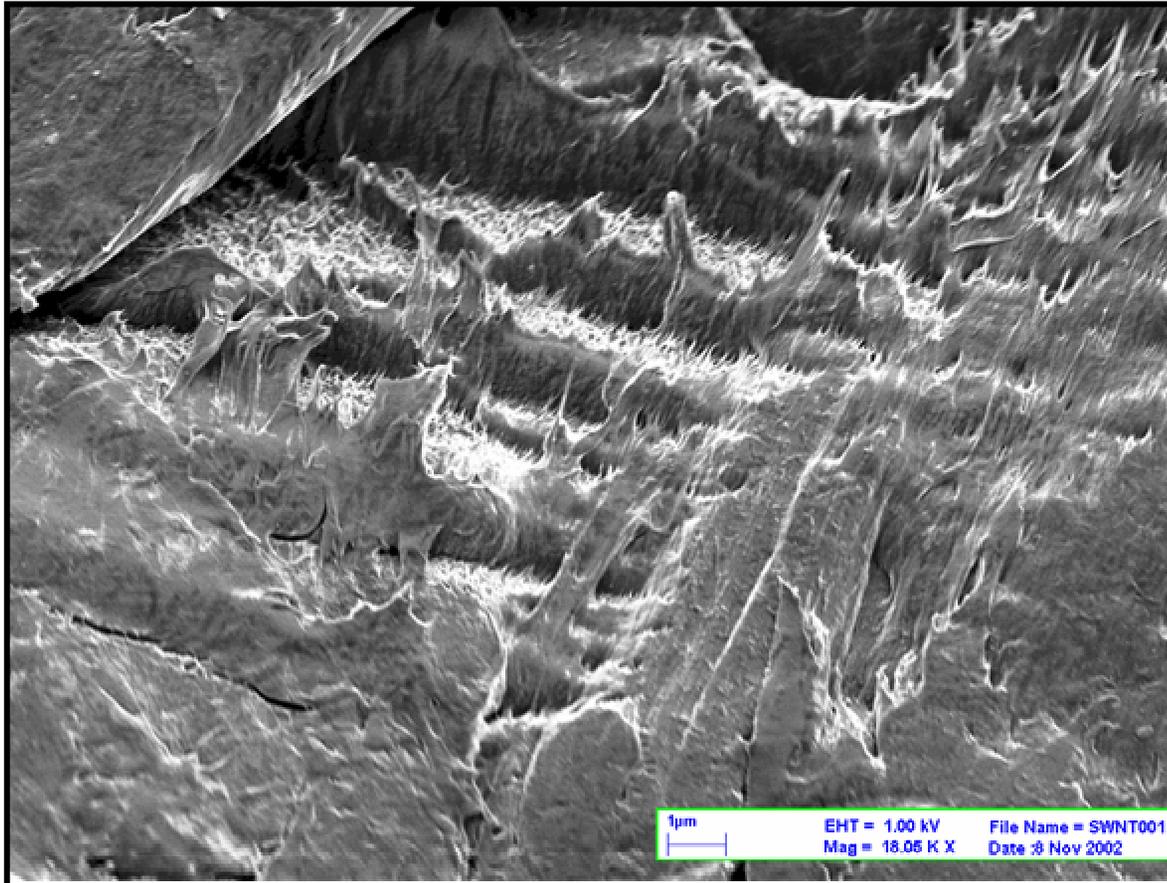
Raw nanotubes



Kentera[™] treated nanotubes

- 50KX magnification at 300 nm
- Equal concentrations
- Multiwall CNTs

Composite fracture surface



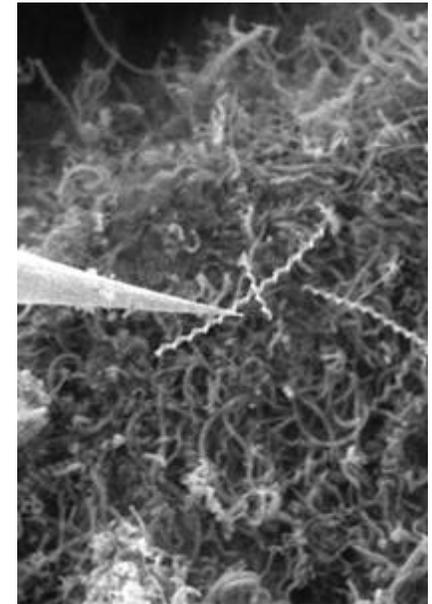
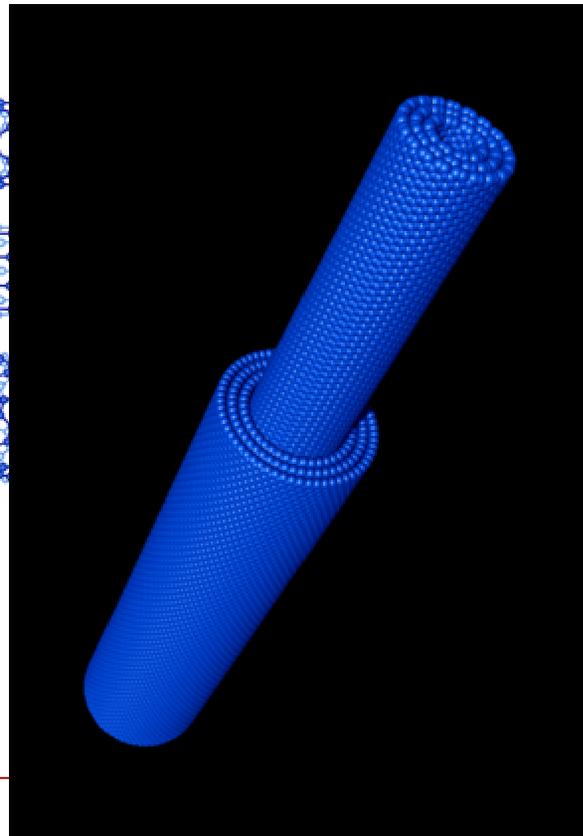
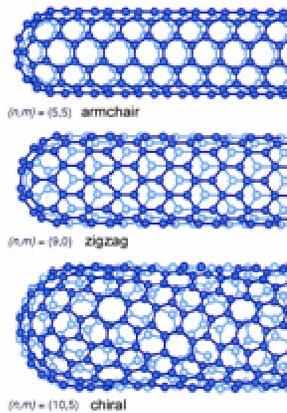
SWNTs in polycarbonate



Supply consistency 2004

- **Preliminary performance data was good**
- **Results weren't repeatable**
- **Can't sell unrepeatable results**

- **Goal: minimize variability**
- **Instituted incoming QA tests**
- **Instituted supply chain management**
- **Certified vendors with repeatable quality and scalable, controllable manufacturing**





zyvex®

NanoSolve™ Products in Use



Additives (Processed CNMs)

- MWNT, SWNT, DWNT, Carbon NanoFibers
- Soluble in organic solvents and water
- Customized for specific applications
- For: Epoxies, Polyurethanes, Polycarbonates

Enhanced Materials

- Polyurethane

Processing Recipes

- Injection molding, Extruding, Casting

Finished Goods

- Thermal Interface Material (TIM)



- **High strength and high stiffness composites – “world’s highest specific strength engineering material” - funded by NASA SBIR Phase II**
 - Aerospace, armor, etc.
- **High toughness composites**
 - Armor, sporting goods, aerospace
- **High thermal conductivity composites**
 - Thermal Interface Materials, Electronics packaging
- **Electrically conductive common plastics**
 - ESD, EMI shielding, conductive cockpit windows

- **Committed to our NanoMaterials business line**
- **Leader in solving “CNT dispersion problem”**
- **Developing a reliable/quality CNT supply chain**
- **Strong IP**
- **Financially stable**
- **Providing a solution (additive + recipe)**
- **Focused on customer specific applications**



www.zyvex.com