

Opportunities for Nanomaterials in Automotive Applications

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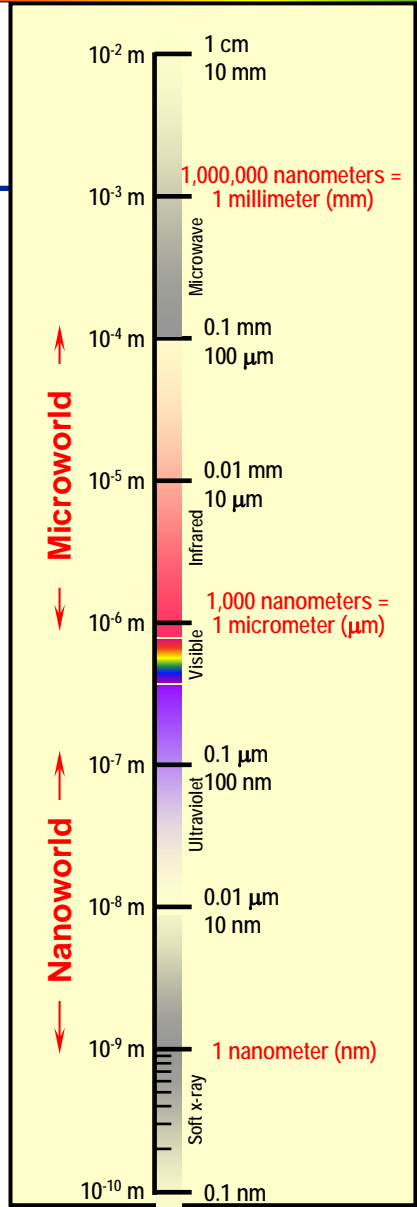
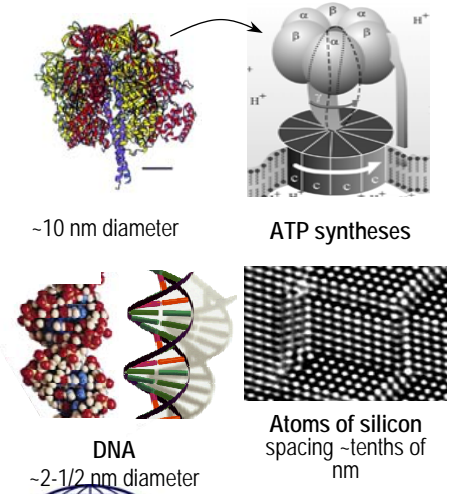
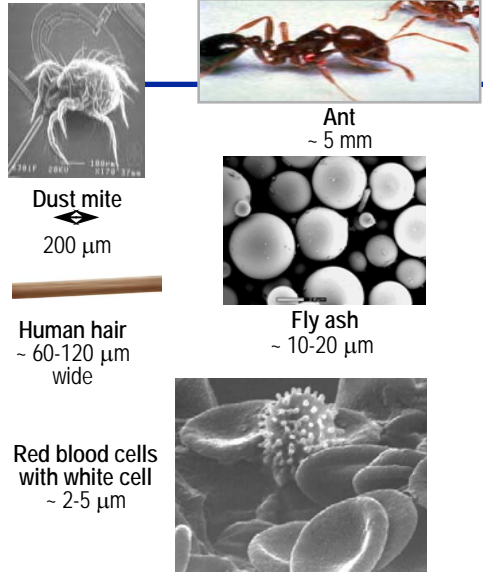
Agenda

- **Introduction to Nanotechnology and Nanomaterials**
- **Automotive industry needs**
 - **Applications**
- **Commercial opportunities and value creation**
- **Conclusions**

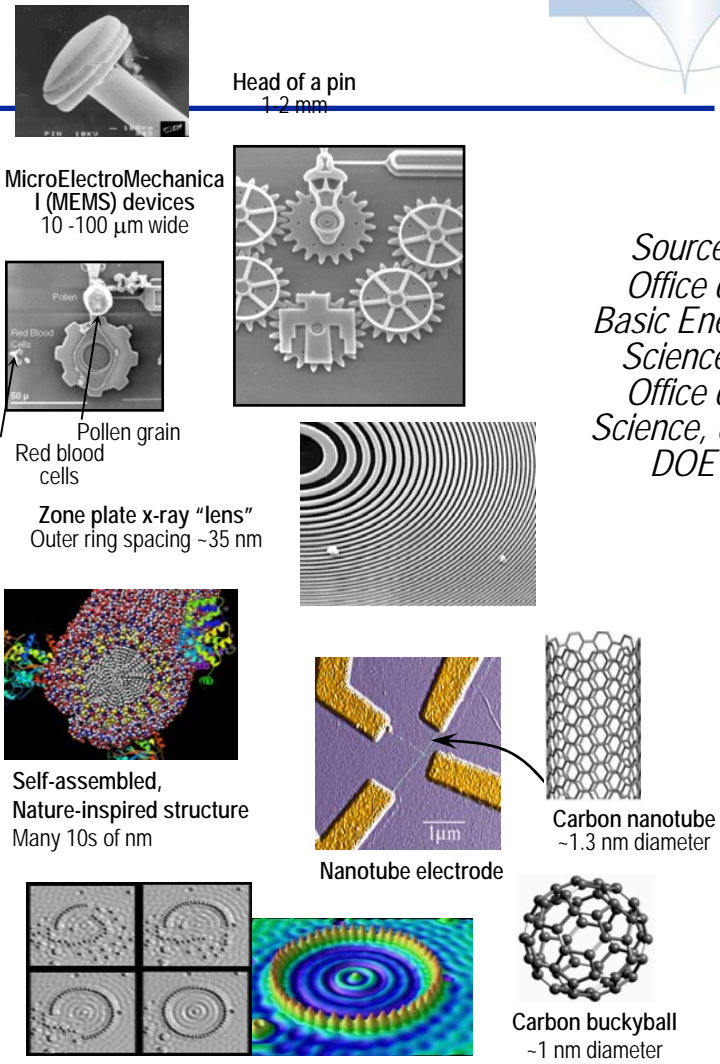
The Scale of Things - Nanometers and More



Things Natural



Things Manmade



Source:
Office of
Basic Energy
Sciences
Office of
Science, U.S.
DOE

Nanotechnology and nanomaterials currently find use in myriad applications....



Daewoo refrigerator containing nano silver



Victor Castano anti-graffiti paint containing silica nanoparticles



Dockers stain-resistant trousers (NanoTex technology)

Sharper Image athletic socks containing silver nanoparticles



Sharper Image plastic storage bags containing silver nanoparticles



GMR disk drive heads



Intel Pentium 4 processor using 90 nm process technology



Lion Corp. antimicrobial sprays containing ionized nano-silver particle attached to the surface of alumina-silica just 15 nanometers in diameter



Samsung OLED displays using nanostructured polymer films



Easton CNT bicycle components



Zelens fullerene-containing cosmetic creams



Boots Soltan sunscreens containing titanium dioxide nanoparticles



Altair's NanoSafe rechargeable nano titanate battery module

...but numerous opportunities exist in virtually all industries



	Technology	Nanoparticles	Nanofilms	Composites	Tools	Devices
<ul style="list-style-type: none"> Energy generation and storage Aerospace/defense Electronics Medicine and health care Food and beverages Textiles and clothing Cosmetics and personal care Construction AUTOMOTIVE 	Sector					
	Information and Communication	Nanowires, transistors, quantum computing, displays	Magnetic films for data storage, lens coatings, semiconductor s	Plastic electronics, flat panel displays	STM, lithography, MBE, AFM, molecular assemblers	MEMS switches, carbon nanotube devices, sensors
	Healthcare and Life Sciences	Drug delivery, image contrast agents, medical dressings	Coated particles, scalpel blades	Medical implants	↓	Lab-on-a-chip, drug discovery, micro-fluidics, microarrays
	Energy and Environment	Fuel additives, catalysts, hydrogen storage	Battery technology, advanced solar cells	Batteries, supercapacitors, fuel cells		Thermoelectric
	Automotive, Aerospace and Industrial	Catalysts, electrodes, lubricants	Advanced coatings (e.g. scratch- and corrosion resistant, antimicrobial)	Exterior and interior parts, engine/powertrain components, fuel-delivery, tires		MEMS sensors, LEDs, optical switches, microcontrollers, displays, actuators
	Other	Cosmetics, personal care products, cosmeceuticals, clothes	Specialist coatings (e.g. for textiles and clothes)	Packaging (food and beverages)		

Source: 3i (Based on a diagram from Evolution Capital)



Automotive industry needs

- **Automotive industry is already one of the largest and most demanding users of material technologies (EPs, PMCs, CMCs, MMCs, steel, aluminum)**
- **The industry helps drive advances in material technologies that bring about cost-effective improvements in vehicle performance, safety, and convenience**
- **Increased environmental and safety legislation dictating the greater use of advanced materials in automotive applications**

Therefore, increased auto demand for high-efficiency, high-performance materials.

Auto applications: a staggering potential

- OEMs and auto part suppliers are already implementing nanotechnology in the production of vehicles

Virtually all aspects of a vehicle could benefit from the use of nanomaterials



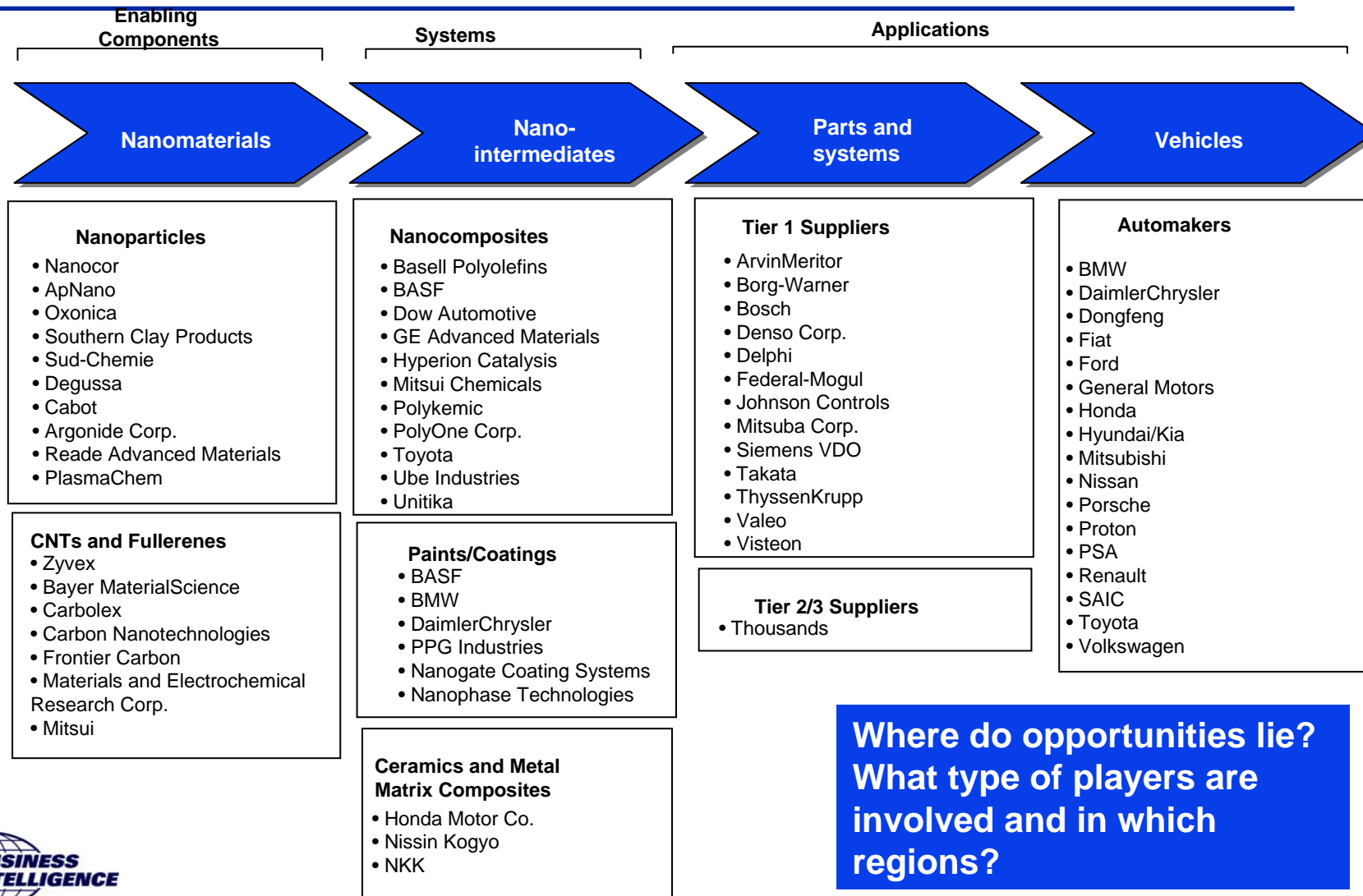
Opportunities and value creation



- Millions of new vehicles produced each year (1000 new vehicles hit the streets of Beijing, China EACH day)
- Millions of current vehicles require new parts and services each year
- Project NanoRoadSME estimates that the design and manufacturing of cars, trucks, and buses can be affected by nanotechnology and related technologies up to 60%
- Frost & Sullivan predicts that by 2015, nanotechnology will apply to 70% of automotive applications, with revenues in the region of \$6.5 billion

But certain constraints may affect uptake: tough time for some automotive OEMs coupled with conservative automotive industry and long product cycles; current nanomaterials price/performance ratios; process-production technologies; material competition, quality, and health and safety issues; and recycling nanomaterials

Potential NM value chain

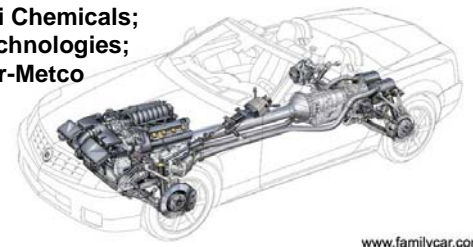


**Where do opportunities lie?
What type of players are involved and in which regions?**



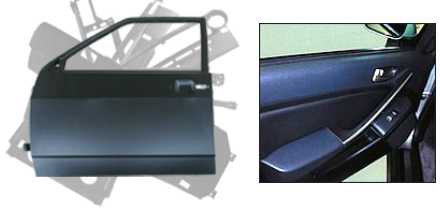
Selected players using nanotechnology for auto applications

ENGINE/POWERTRAIN:
CRF; GE Plastics; Aveka;
Audi; Mitsui Chemicals;
Synkera Technologies;
Ford; Sulzer-Metco



www.familycar.com

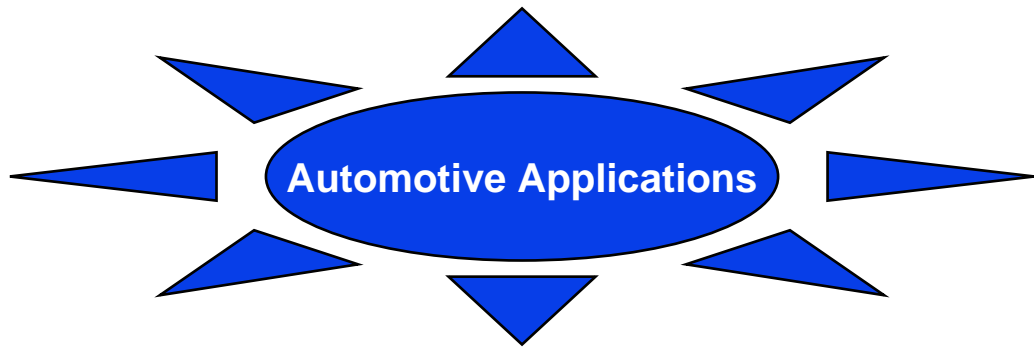
EXTERIOR/INTERIOR PARTS: Bayer;
Blackhawk; GM; GE Plastics; SportRack
Automotive; Toyota; Dow Automotive;
Honda; smart GmbH; JFE (NKK and
Kawasaki Steel)



TIRES: Bridgestone;
Continental; Cabot;
Degussa; Michelin; InMat



FUEL DELIVERY/STORAGE: Toyota;
Ube Industries; Unitika



PAINTS/COATINGS: BASF;
BMW; DaimlerChrysler;
Hyperion Catalysis; PPG;
Sustech; DuPont; Ecology
Coatings' CRF (NANOMAG
project)



LUBRICANTS: ApNano
Materials; PlasmaChem;
VW; Hatco



**AUTOMOTIVE
ELECTRONICS:** Fujitsu;
Infineon; Continental;
Bosch; Siemens; Synkera
Technologies



SUSPENSION/BRAKING: Continental
Teves; Bridgestone; Honda; Lord
Corp.; Strem Chemicals; TWR



**EXHAUST
SYSTEMS/CATALYTIC
CONVERTERS/FUEL
CELLS/BATTERIES:** A123
Systems, Altair; Engelhard;
Oxonica; Nanophase;
QinetiQ; Strem Chemicals;
Nanostellar; Catalytic
Solutions; Nanox; Umicore



Who gains and who loses? —2 examples: nanocomposites and nanocoatings



- **Nanocomposite body panels**

Value chain participant	Value shift as a result of nanotechnology	Gain/Loss
Consumer	Lower fuel consumption More durable parts and better performance	Gain
Auto Manufacturer	Cost savings of nanocomposites over conventional talc-filled composites Easier manufacturing; greater design flexibility; use of lighter engine and suspension	Gain
Plastic supplier	Increase in the amount of plastic sold to OEM per vehicle	Gain
Nanoclay supplier	Increased sales	Gain
Petroleum company	Lower fuel consumption (less gas sold)	Loss
Conventional talc filler supplier	Reduced sales	Loss

The environment also gains through reduced emissions and easily recyclable parts



Who gains and who loses?

- **Nanocoatings**

Value chain participant	Value shift as a result of nanotechnology	Gain/Loss
Consumer	Wash car less often Less likely to repair windshield Improved appearance (possible higher resale value)	Gain
Consumer	Cost of nanocoatings passed on by OEM	Loss
Auto Manufacturer	Reduction in warranty claims Improved appearance (higher resale value for vehicles bought out of lease)	Gain
Coating manufacturer	Increased sales of nanocoatings	Gain
Car wash/detailing shop	Cars are washed less often	Loss
Auto glass repair company	Windshields less likely to require repair	Loss

Source: Lux Research; SRIC-BI



Conclusions

- **Nanotechnology will likely emerge as a key technology in automotive manufacture, especially in the materials replacement arena**
- **Today, nanocomposites, coatings, and paints see use; nanocatalysts, nanodispersions and nanoadditives in lubricants, fuels, and coolants will follow**
- **Players will need to address a number of issues, but the possibility exists for:**
 - **Auto OEMs to gain through improved product performance, cost savings and meeting environmental and safety legislation**
 - **Tier 1 suppliers to gain through increased demand from auto OEMs for high-performance materials and systems**
 - **Greater competition between Tier 2 suppliers as new players join the mix**
 - **Consumers to gain through better performing vehicles and cost savings**



For Further Information

See our Explorer Nanomaterials web page:

<http://www.sric-bi.com/Explorer/NM.shtml>

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