



Nanotechnology Enabled Materials for Energy Conservation



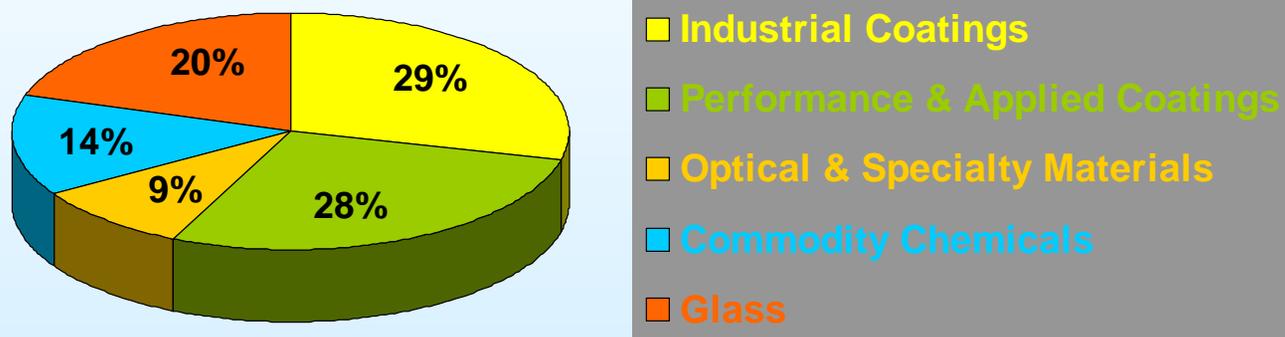
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*Pollution Prevention through Nanotechnology Conference
EPA: September 25, 2007*

The Company



- ◆ Founded in 1883
- ◆ Global headquarters in Pittsburgh, PA
- ◆ 2006 revenue \$11.0 billion



- ◆ 2006 R&D spending \$334 million
- ◆ 5 research & development locations
- ◆ 125 production facilities in 23 countries
- ◆ Approximately 32,200 employees



5 Major Sectors & 15 SBUs



Industrial Coatings

- ◆ Automotive Coatings
- ◆ Industrial Coatings
- ◆ Packaging Coatings

Performance & Applied Coatings

- ◆ Aerospace
- ◆ Architectural Coatings
- ◆ Automotive Refinish
- ◆ Marine & Protective Coatings

Optical & Specialty Materials

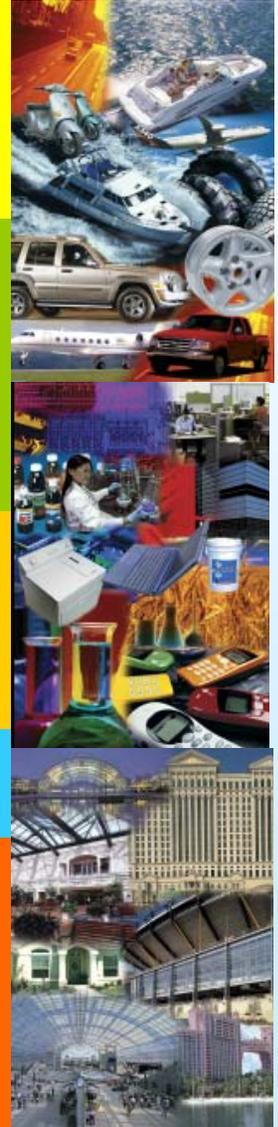
- ◆ Fine Chemicals
- ◆ Optical Products
- ◆ Silicas

Commodity Chemicals

- ◆ Chlor-Alkali and Derivatives

Glass

- ◆ Automotive OEM Glass
- ◆ Automotive Replacement Glass
- ◆ Fiber Glass
- ◆ Performance Glazings

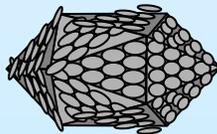


What is Nanotechnology?

- ◆ Nanotechnology deals with systems comprising at least one dimension between 1-100 nm (billionth of a meter)
 - Allows for the control of physical and chemical properties of structures at the molecular level
 - Materials in the nanometer scale exhibit physical properties distinctively different from those of bulk and micrometer scale
- ◆ Nanoscale electronics, optics, sensors
- ◆ Nanobiological systems, nanomedicine, imaging
- ◆ **Nanomaterials, nanostructures, nanocomposites**



DNA
2.5 nm



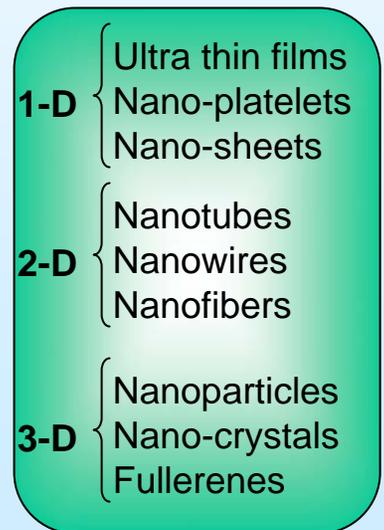
Virus
50 nm



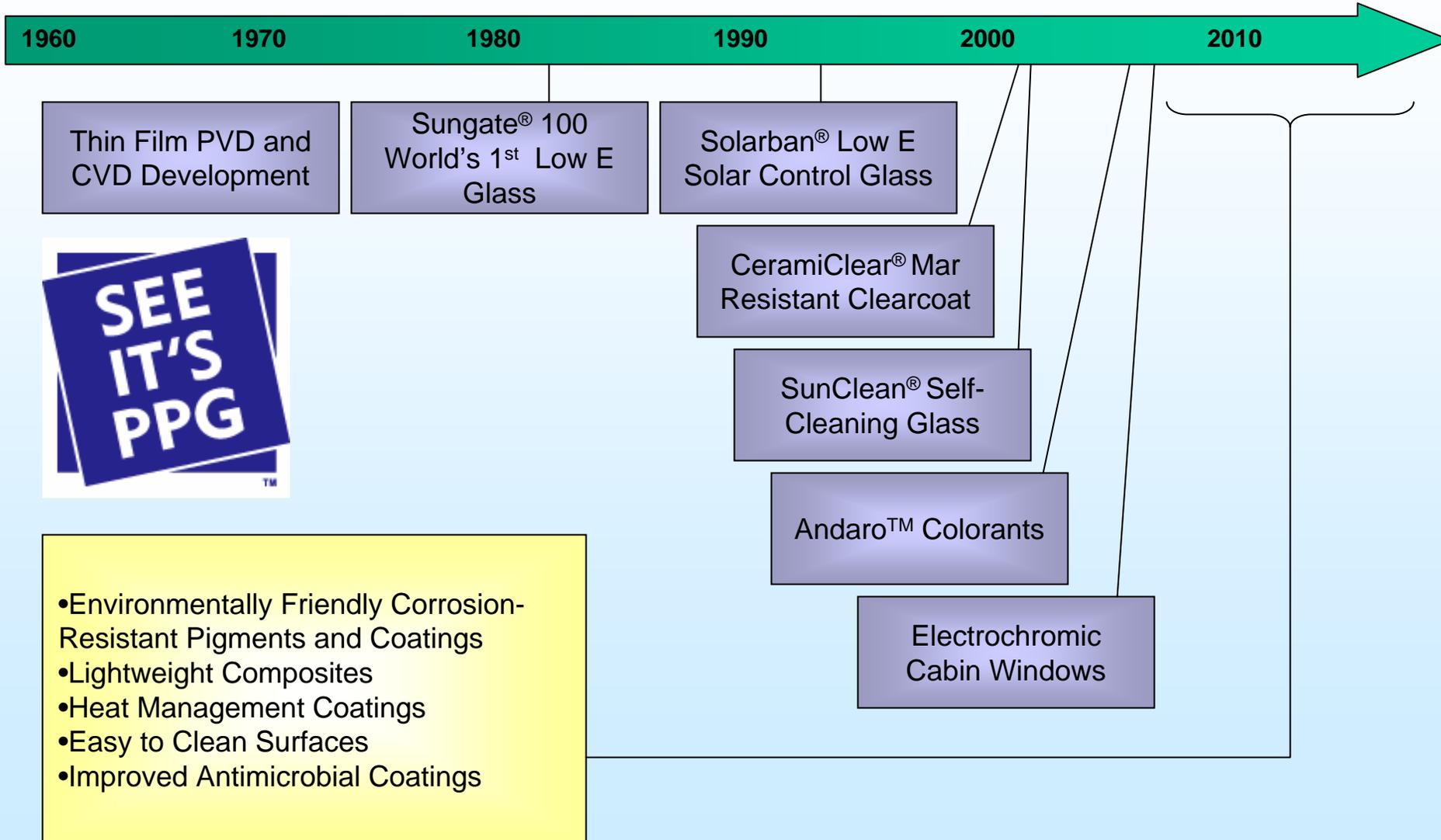
Bacteria
500 nm



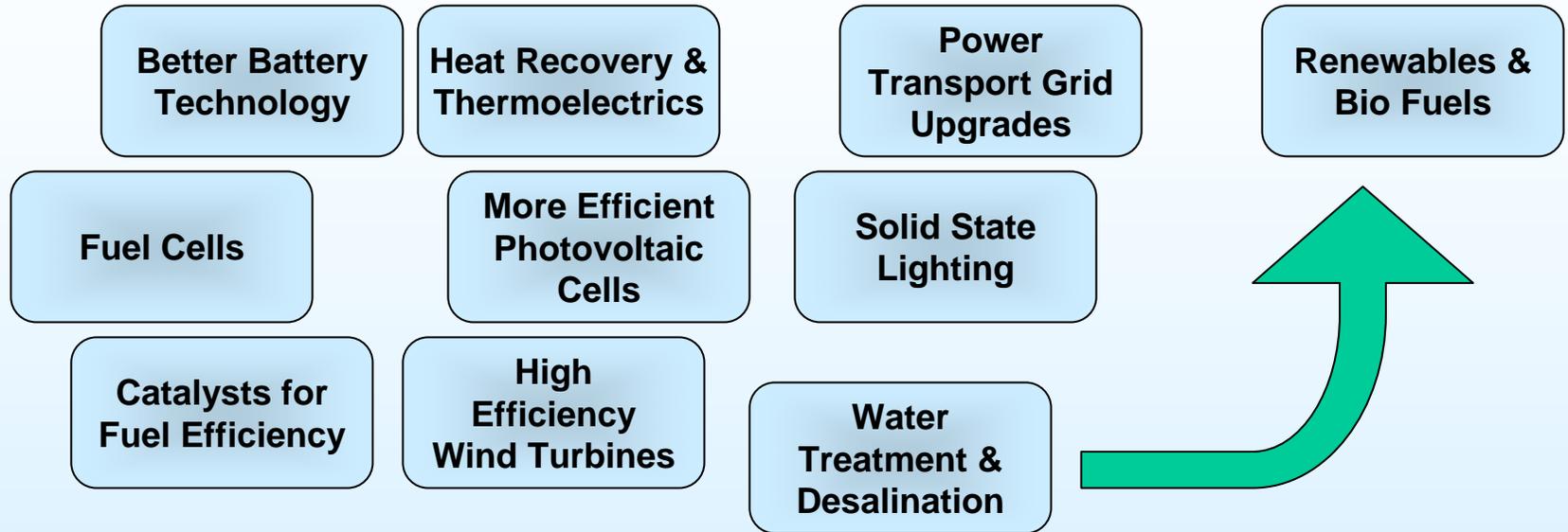
Human Hair
10,000 nm



“Nano” Commercialization History



Nanotechnology for Energy



Future



What can we leverage today?

**Nano-Materials
for Energy Conservation**

Nanotechnology in Glass Products

Pioneers in Thin Film Coating Technology

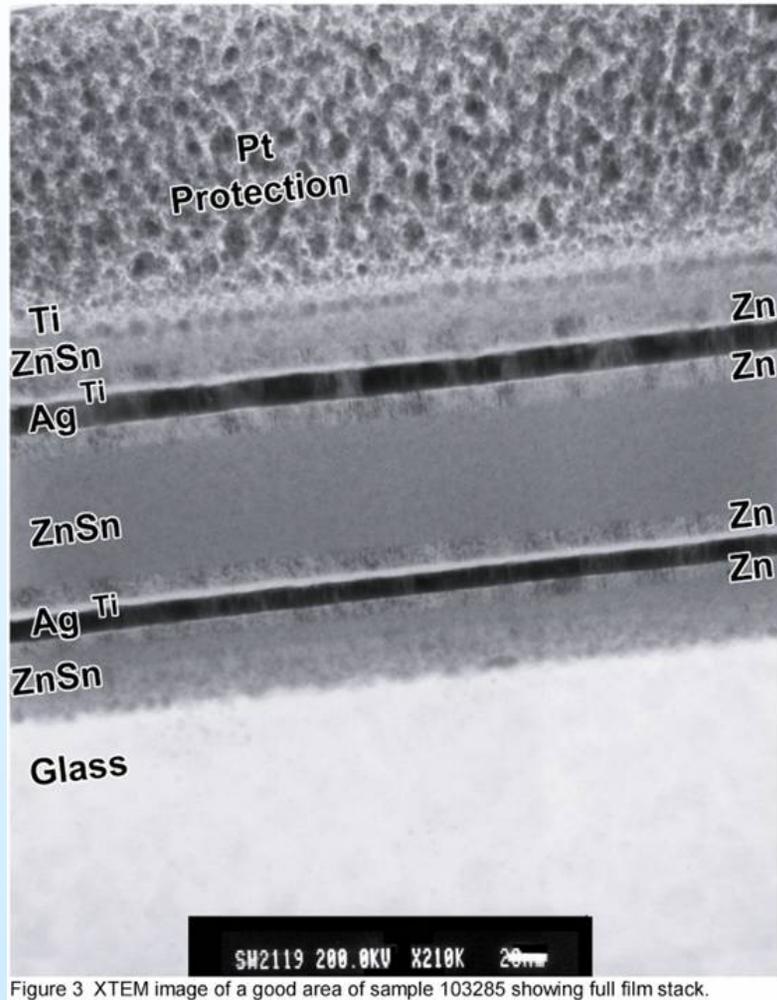
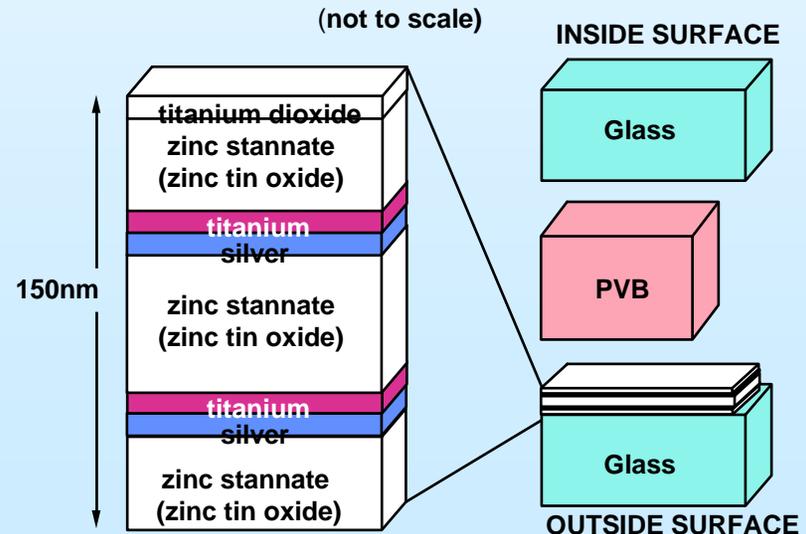
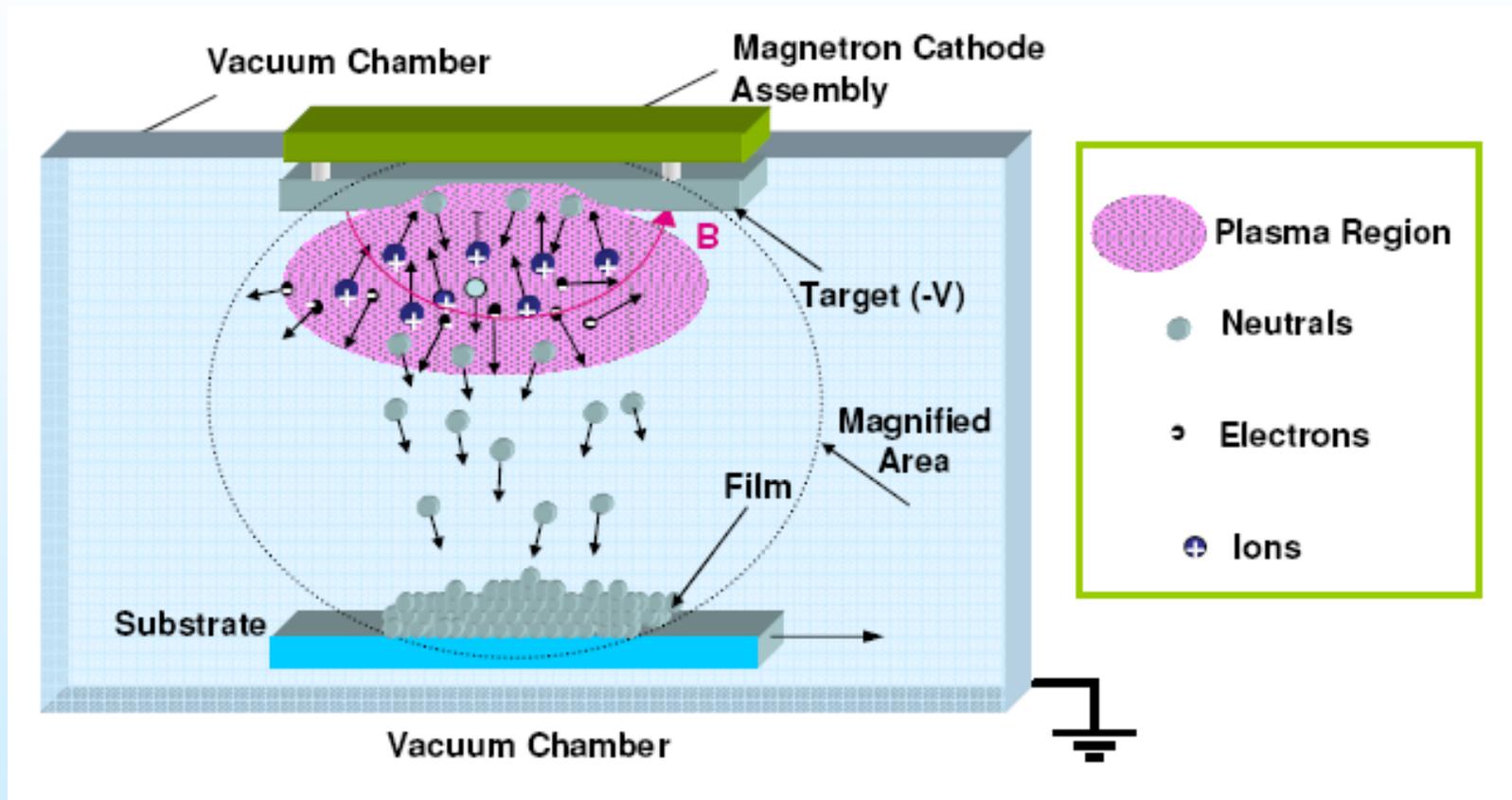


Figure 3 XTEM image of a good area of sample 103285 showing full film stack.

- ◆ Design & modeling of multilayer interference thin film coatings
- ◆ Large-scale chemical vapor deposition (CVD)
- ◆ In-line magnetron sputtering vacuum deposition (MSVD)
- ◆ Transparent coated product manufacturing compatibility
 - Solar thermal HLR and low-emissivity functions
 - Coat flat and bend automotive glazing
- ◆ Development of conducting, high transmittance coatings for heated transparencies, window antennae, and electrochromic window units

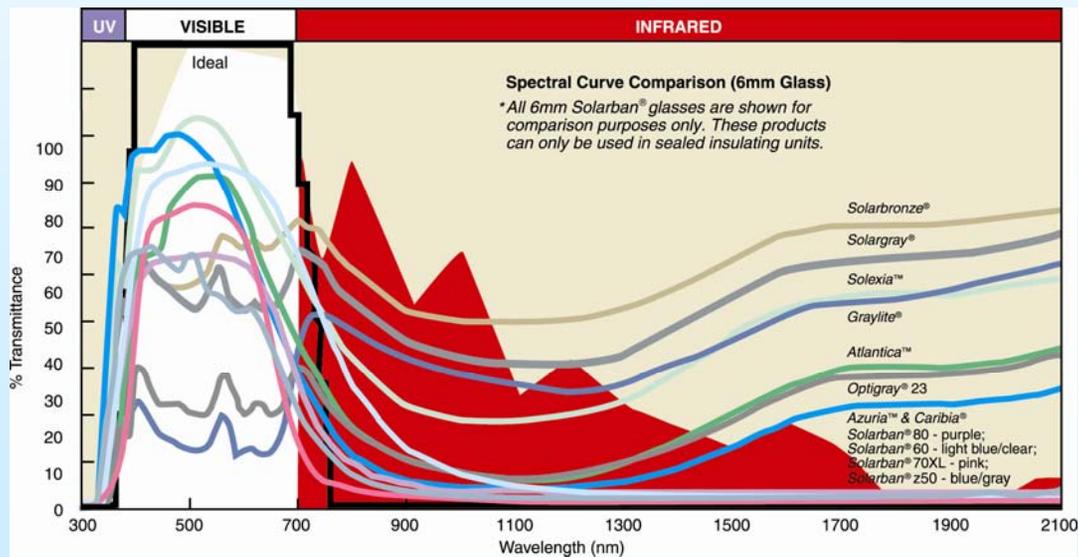


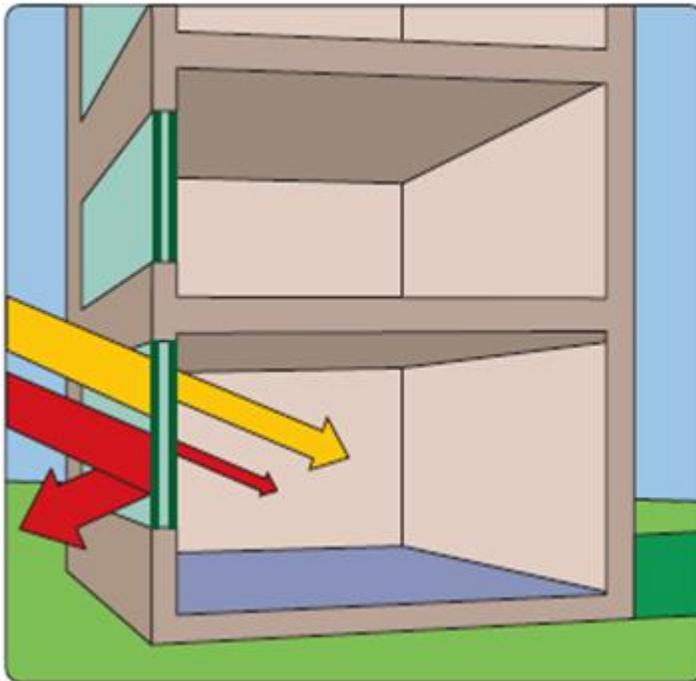
Magnetron Sputtering



Schematic of MSVD system and coated glass plate (not to scale)

Solar Control Low-E Glass





New *Solarban*® 70XL Glass

Solarban® 70XL transmits 63 percent of the available visible light while permitting only 27 percent of the sun's solar energy (heat) to pass through. The resulting Light to Solar Gain (LSG) ratio of 2.33* surpasses, by far, the performance of any existing architectural glass product.

-  Visible Light Transmittance: 63%
-  Solar Heat Gain Coefficient: 0.27
- Light to Solar Gain (LSG) Ratio: 2.33

Superior solar performance without major reduction of visible light transmittance or addition of noticeable color

**Light to Solar Gain (LSG) ratio is a single figure that indexes the overall performance of the glass. The higher the LSG number, the better the glass is at delivering visible light, while blocking solar energy. The U.S. Department of Energy recommends glass with an LSG ratio of 1.25 or greater for all commercial buildings.*

Energy & Carbon Footprint Management



Carbon Savings for 8-story Office Building with Wall Windows

Glazing	Location	Cooling kWh savings	Yearly CO2 savings (tons)	CO2 - 25 year bldg life (tons)	Yearly CO2 savings (lbs/sqft)
Dual Pane Tint	Boston	baseline	n/a	n/a	n/a
Solexia / Sungate 500	Boston	364,109	291	7,282	10.3
Solarban 60	Boston	490,436	392	9,809	13.9
Solarban z50	Boston	608,059	486	12,161	17.2
Solarban 70XL	Boston	681,589	545	13,632	19.3
Solarban 80	Boston	726,378	581	14,528	20.5
Dual Pane Tint	St. Louis	baseline	n/a	n/a	n/a
Solex / Sungate 500	St. Louis	413,610	331	8,272	11.7
Solarban 60	St. Louis	554,103	443	11,082	15.7
Solarban z50	St. Louis	688,268	551	13,765	19.4
Solarban 70XL	St. Louis	771,312	617	15,426	21.8
Solarban 80	St. Louis	825,093	660	16,502	23.3

Sqft of glass area

56,640

Life-Cycle Example: Carbon Payback



For coated insulating glass

- ◆ Clear Float Glass: 0.91 Kg CO₂ / m²
- ◆ Coating: 0.16 Kg CO₂ / m²

- ◆ Annual CO₂ Savings*: 91 Kg CO₂ / m²
- ◆ Almost a 600-fold CO₂ savings per year!

* Dual-pane insulating glass versus clear glass

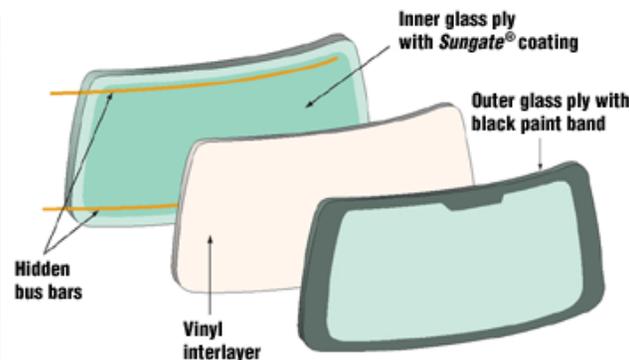
Sungate[®] Solar Control Windshields



- ◆ Temperature reduction in vehicle
 - More comfortable driving conditions
- ◆ Reduction in work load of air conditioner compressor
 - Reduces cool down time by 50%
 - Saves in fuel consumption
- ◆ Protects interior fabrics
- ◆ Additional functions
 - Antennae
 - Uniform heating for de-icing
 - Color styling



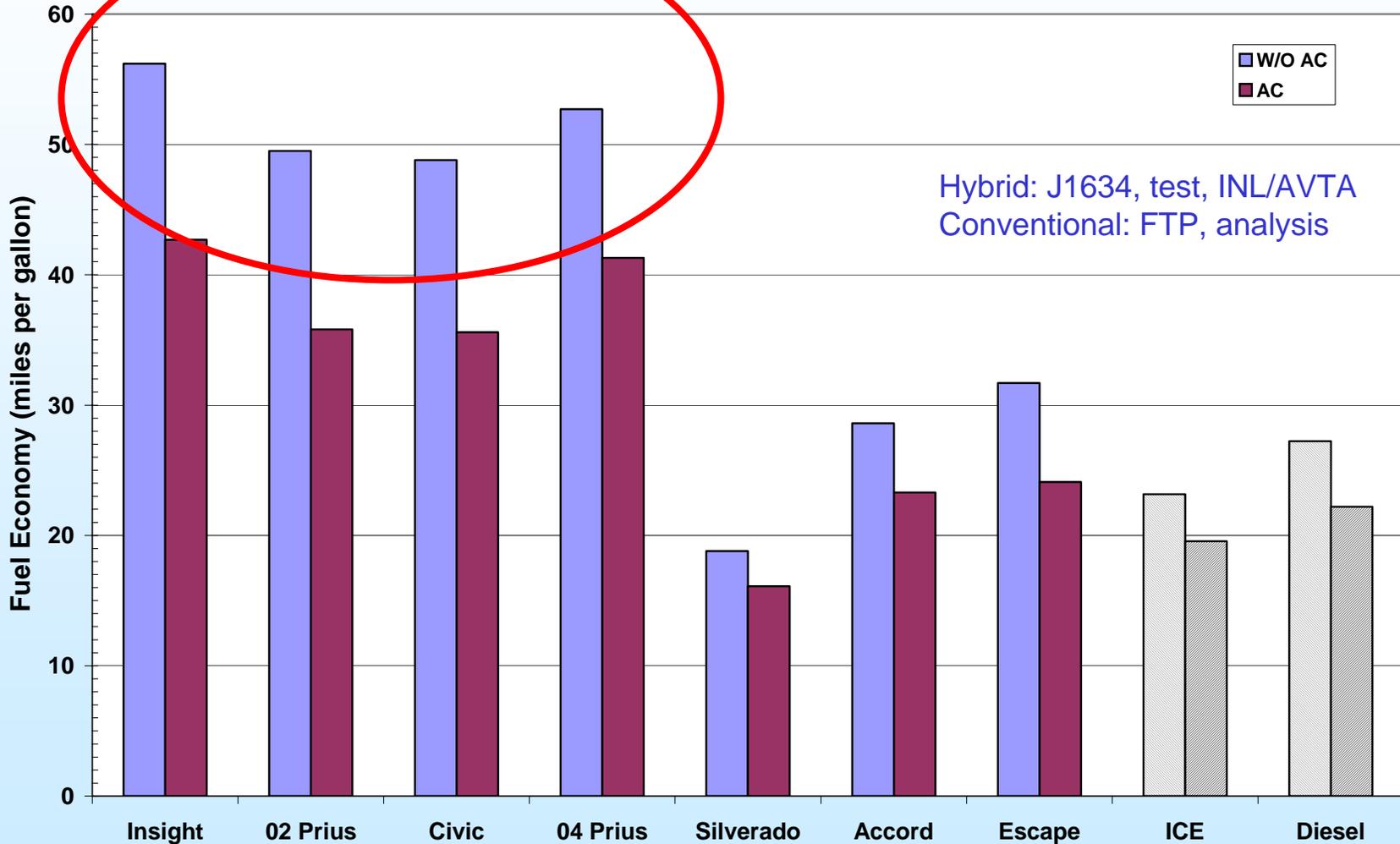
Sungate WeatherMaster[™] Windshield Construction



Fuel Economy Impact from A/C



A/C fuel use on high mpg vehicles significantly drops efficiency

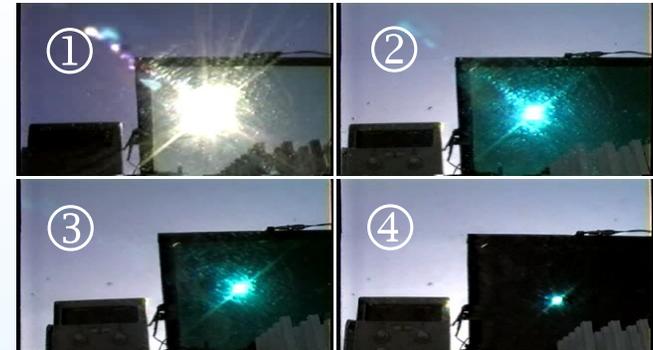


Source: National Renewable Energy Laboratory

Emerging Materials Products



◆ Electrochromic windows



◆ “Cool” roofing materials

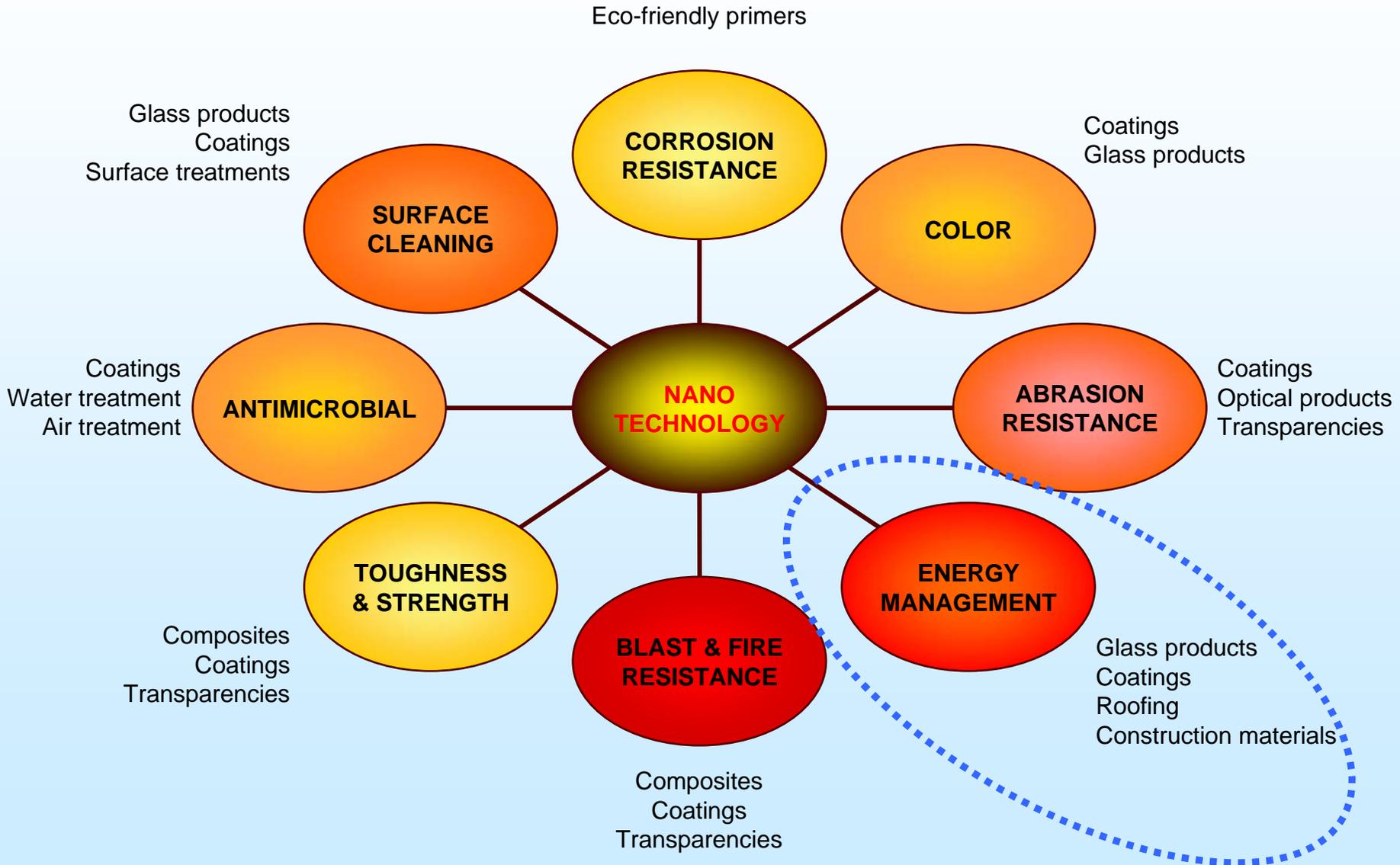
◆ Energy conservation coatings



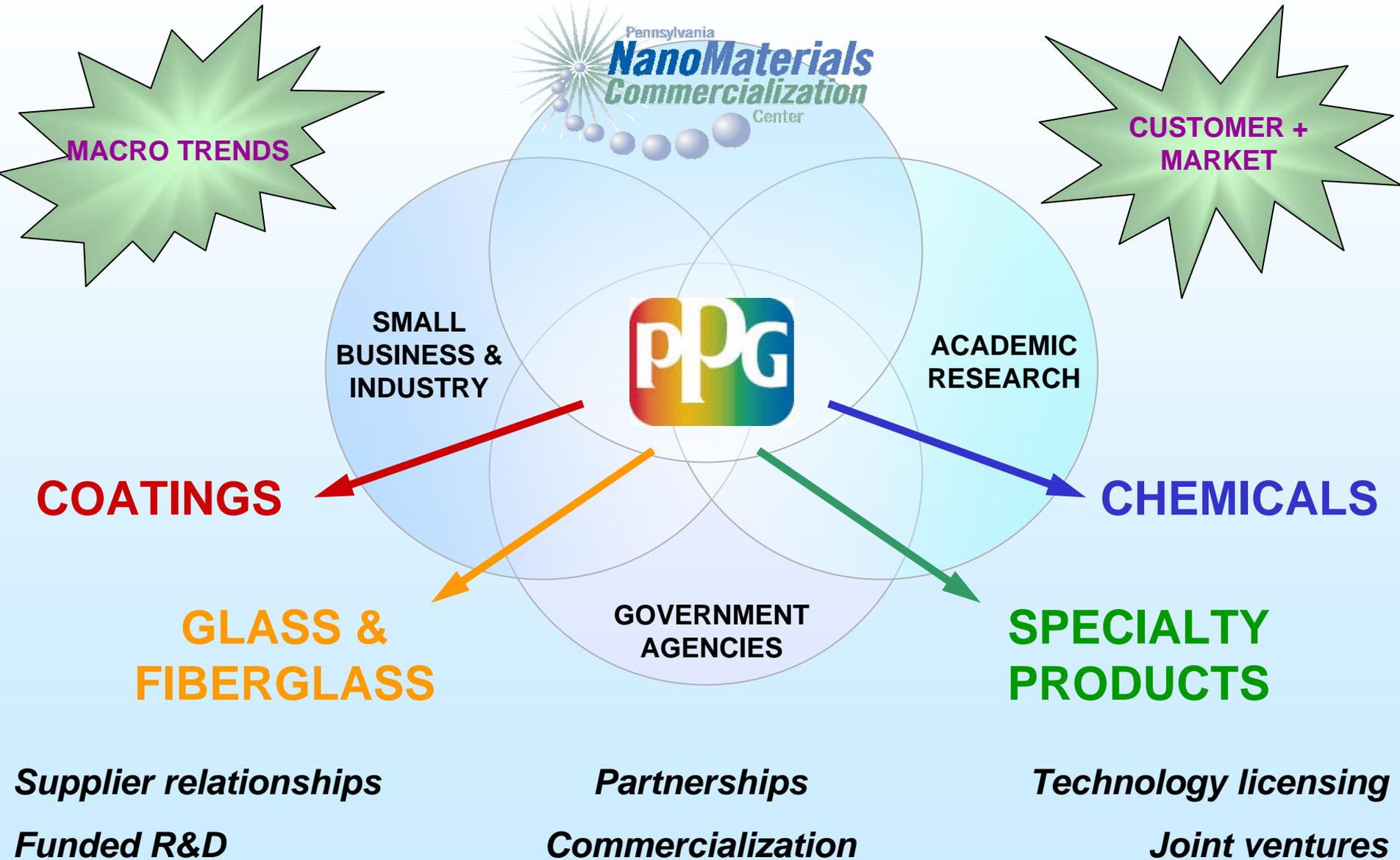
◆ Switchable coatings and materials

◆ Active filtration materials for air & water treatment

Materials Enhancement



Nano Commercialization Model



Stewardship



- ◆ ACC Nanotechnology Panel
 - EPA cooperation: voluntary program, NMSP, etc.
 - International collaboration
 - Industry coalition and communication
- ◆ Nanoparticle Benchmarking Occupational HSE Project
 - Industry led consortium to help address current needs
- ◆ Internal nanomaterial environmental, health & safety programs
 - Guidelines, handling, communication
 - Product stewardship