



# Nanotechnology: Current Successes and Current Challenges



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Prepared for the President's Council of Advisors on  
Science and Technology  
Monday, June 25, 2007



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## Theme

The nanotechnology  
revolution is all around us –  
but more work is needed to  
realize all its potential



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## Agenda

- Nanotech has moved from discovery to commercialization
- Commercialization poses new challenges
- The outlook for the U.S.



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## World-changing technologies move from *discovery* to *commercialization*



Discovery phase

Commercialization phase



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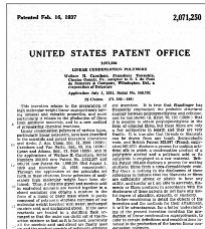
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## Plastics



1920s



1937



1939



1970s

Discovery phase

Commercialization phase



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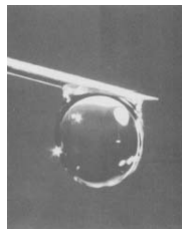
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## Biotech



1953



1973



1976



1980s+

Discovery phase

Commercialization phase

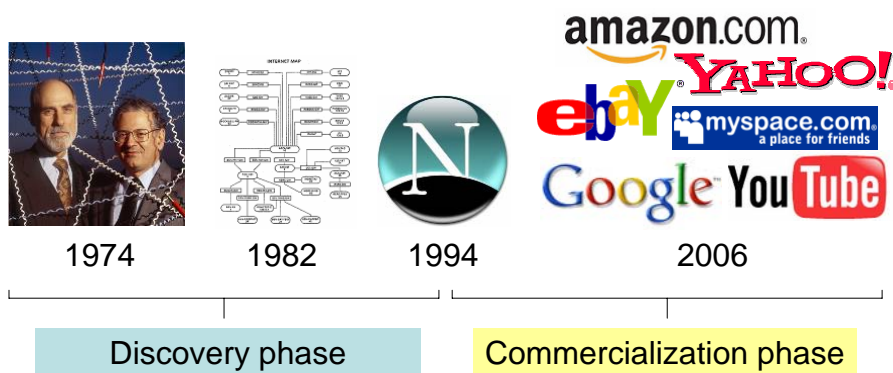


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## Internet

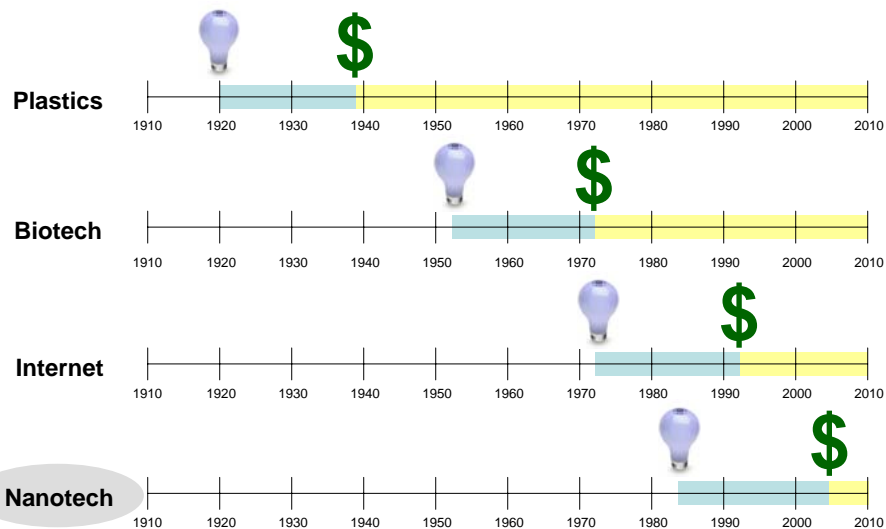


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## Nanotechnology fits the same commercialization pattern



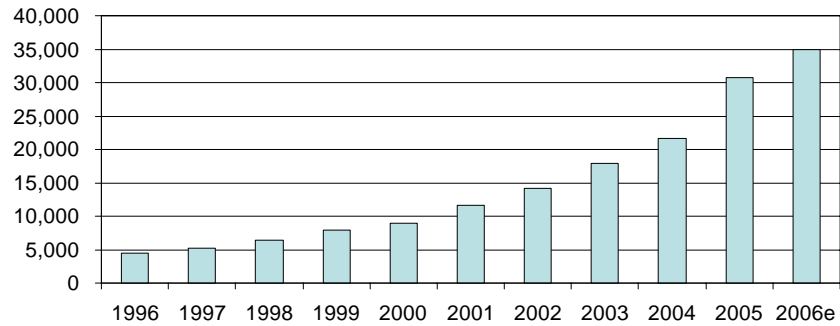
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## Discovery keeps growing...

Journal articles on nanotechnology topics, 1996 to 2006



Source: Science Citation Index searches. Search string: TS=(quantum dot OR nanostruc\* OR nanopartic\* OR nanotub\* OR fullerene\* OR nanomaterial\* OR nanofib\* OR nanotech\* OR nanocryst\* OR nanocomposit\* OR nanohorn\* OR nanowir\* OR nanobel\* OR nanopor\* OR dendrimer\* OR nanolith\* OR nanoimp\* OR nano-imp\* OR dip-pen)



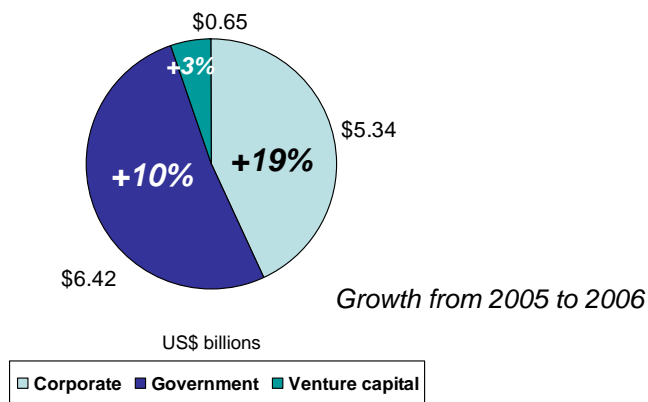
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## ...but gets eclipsed by commercialization

Nanotechnology funding worldwide in 2006



Sources: Lux Research Reference Study "The Nanotech Report, 4th Edition"; Lux Research Reports "How Industry Leaders Organize for Nanotech Innovation"; "Ranking the Nations: Nanotech's Shifting Global Leaders"; "Making Sense of Nanotech Venture Capital"



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Advertisement for DeWalt and A123 Systems. The image displays several DeWalt power tools: a flexible neck work light, a reciprocating saw, a circular saw, a cordless drill, a jigsaw, and a cordless impact driver. The DeWalt logo is prominently displayed in the center. Below the tools, the A123 Systems logo is shown. At the bottom, the Lux Research Inc. contact information is provided.

**DeWALT**

**A123 SYSTEMS**

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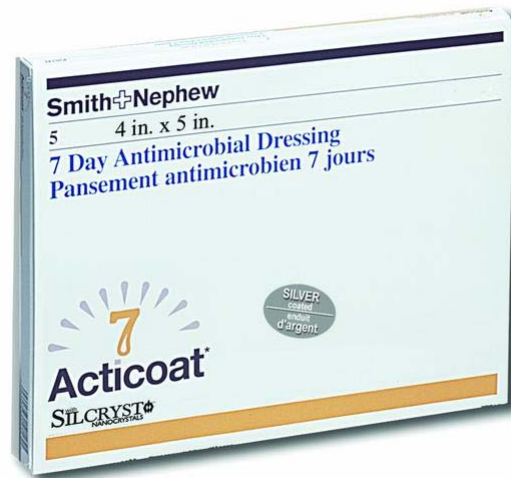
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Advertisement for various pharmaceutical products. The image displays several medications and their packaging:

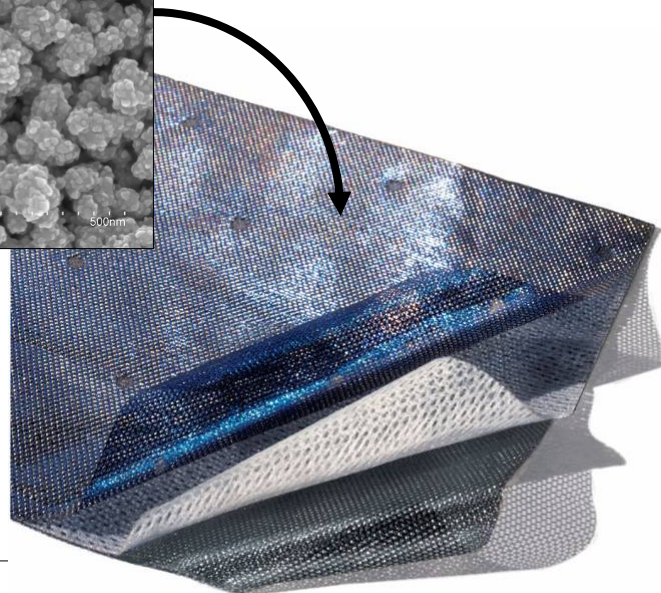
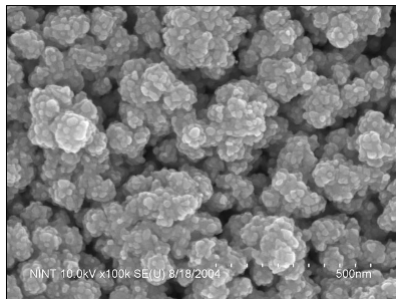
- Abraxane**: A vial of 100 mg Abraxane (paclitaxel) injection.
- Doxil**: A vial of 20 mg in 25 mL (2 mg/mL) sterile, single use vial of Doxil (doxorubicin HCl liposome injection).
- Megace**: A bottle of 240 mL (8 fl. oz.) Megace Oral Suspension (megestrol acetate).
- Rapamycin**: A box and blister pack of Rapamycin 2 mg (testosterone) tablets.
- Estrasorb**: A box and blister pack of Estrasorb 2.5 mg estradiol tablets.
- Tricor**: A bottle of 54 mg Tricor (fenofibrate) tablets.



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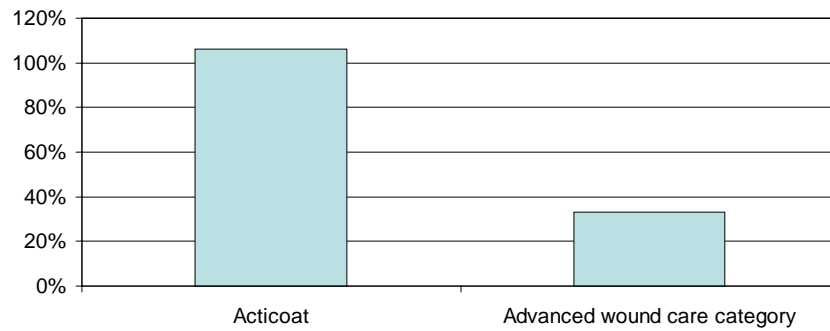
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## Smith & Nephew's nano-enabled Acticoat outgrew its product category by 3x

Smith & Nephew Acticoat growth versus advanced wound care market growth, 2004 to 2006



Source for Acticoat growth: Smith & Nephew reports.  
Source for advanced wound care market growth: L.E.K. Alkar Consulting.

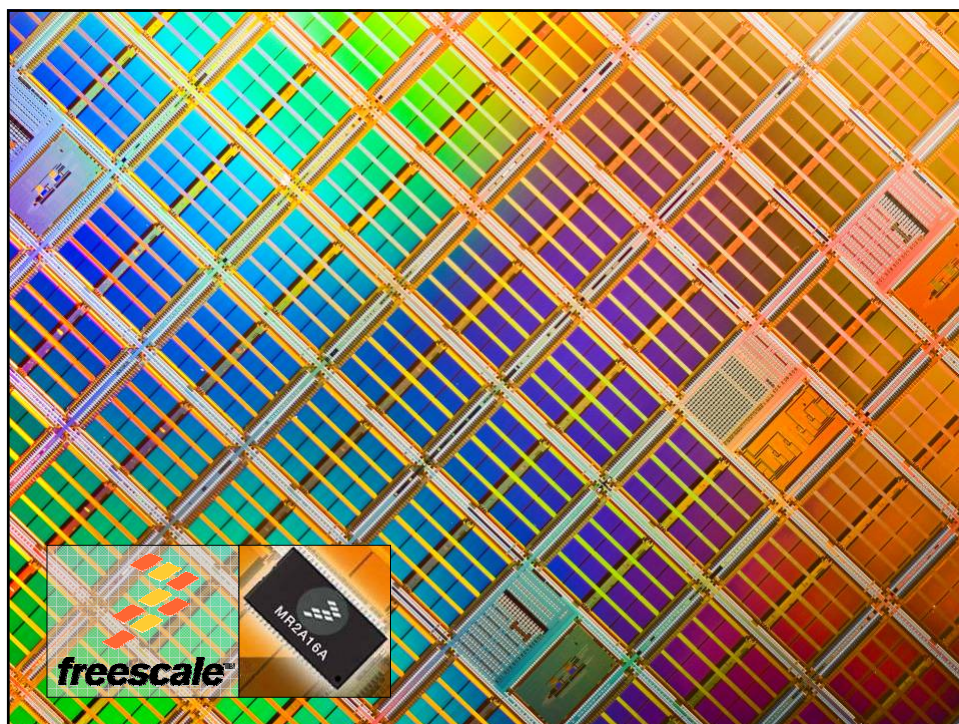


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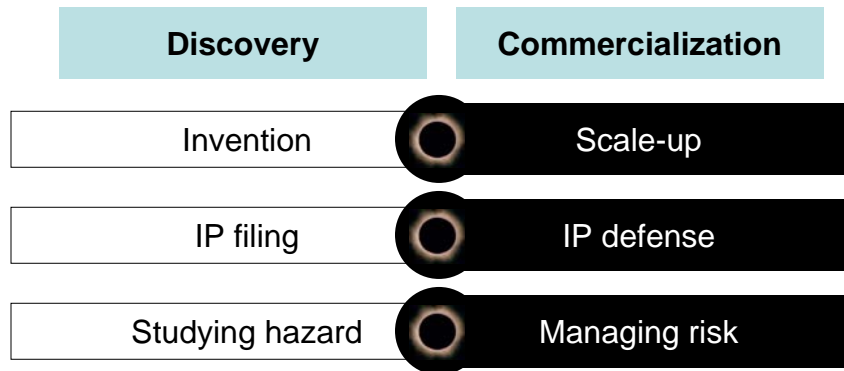


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## New challenges eclipse old ones

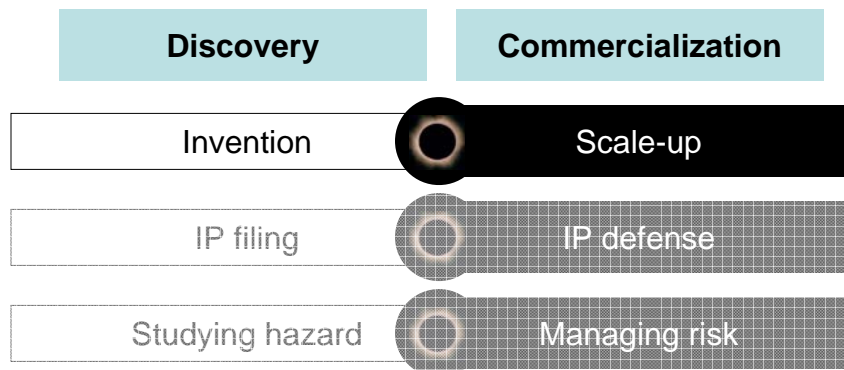


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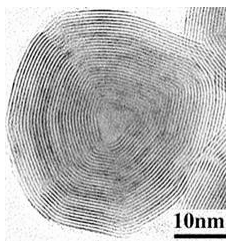
## From invention to scale-up



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## From IP filing to IP defense

Discovery	Commercialization
Invention	Scale-up
IP filing	IP defense
Studying hazard	Managing risk

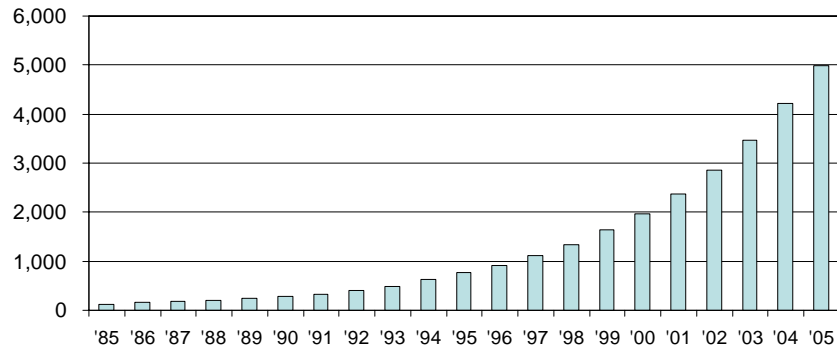


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## Nanotech patents issued continue to grow

Total number of U.S.-issued nanotechnology patents, 1985 to 2005



Source: June 2006 Lux Research report "Nanotech IP Battles Worth Fighting."



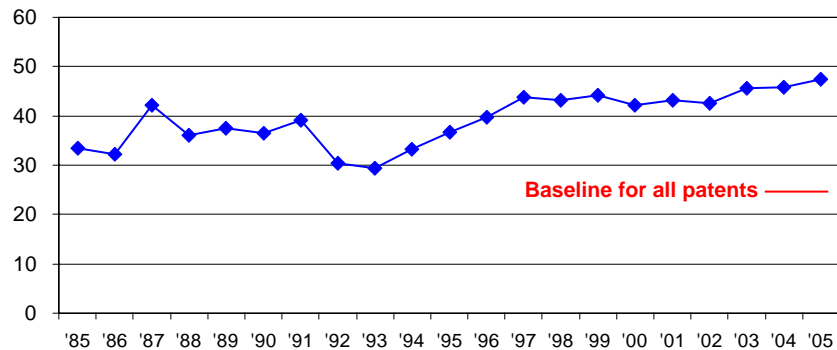
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## The bottleneck is the USPTO

Average pendency (time from application to issuance) for U.S. nanotech patents in months, 1985 to 2005



Source: June 2006 Lux Research report "Nanotech IP Battles Worth Fighting."

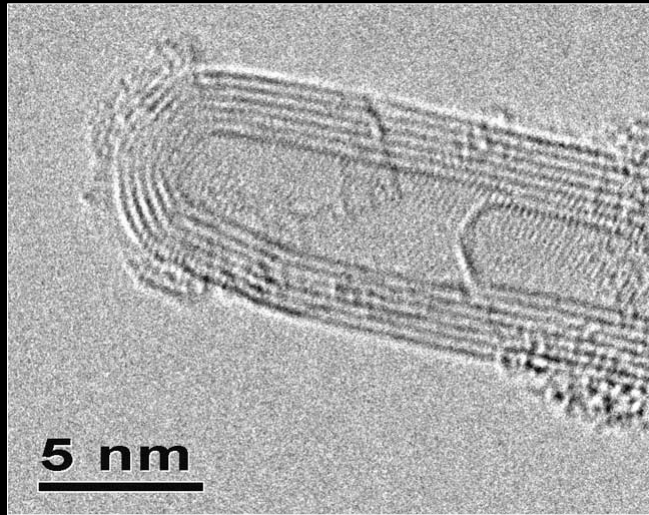


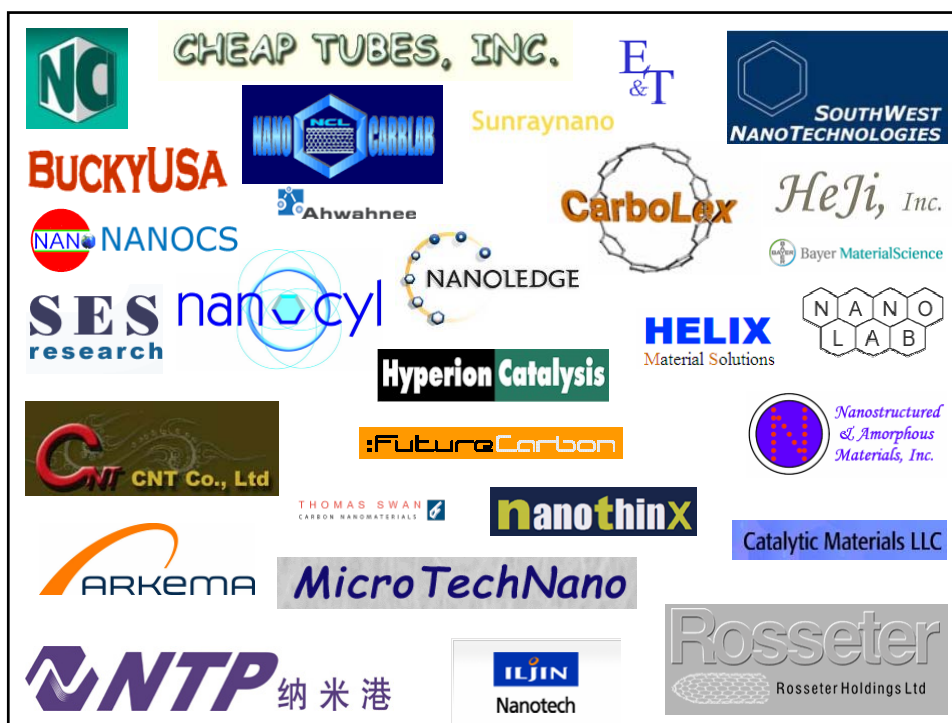
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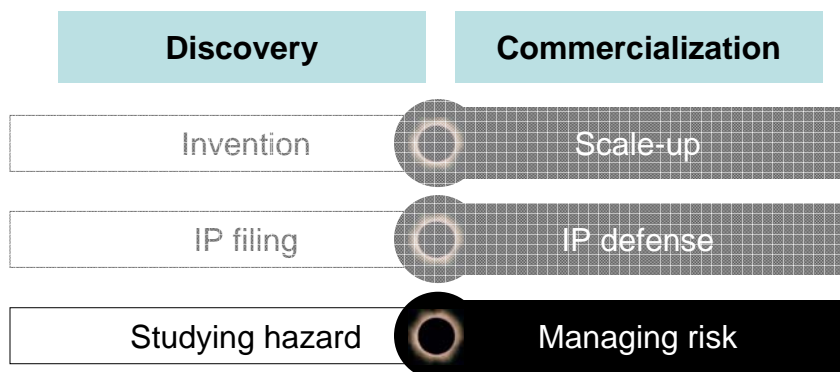
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## From studying hazard to managing risk



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## Firms need to handle three aspects of nanotech EHS...

### Real risks

Nanomaterials might have negative effects on people or the environment



Rat exposed to cobalt nanoparticles on the left side, bulk cobalt on the right side

**Best case:** Nanomaterials prove to be more dangerous than ordinary substances in only a handful of cases

**Worst case:** Studies show that many nanomaterials have elevated hazard and are more difficult to control

### Perceptual Risks

Nanotechnology might come to be seen as unsafe – irrespective of actual harm



Protest of the use of Nano-Tex fabric treatment outside an Eddie Bauer store

**Best case:** Consumers appreciate the benefits nanomaterials can offer and embrace the technology

**Worst case:** Nanotech comes to be seen as synonymous with danger and consumers are reluctant to accept it

### Regulations

Regulations might – rightly or wrongly – slow or block commercialization



Text of the Environmental Protection Agency's Toxic Substances Control Act

**Best case:** Existing regulatory frameworks can be painlessly adapted to manage nanomaterials

**Worst case:** Risks drive regulators to impose stringent testing requirements on all nanomaterials

Source: May 2006 Lux Research Report "Taking Action on Nanotech Environmental, Health, and Safety Risks"



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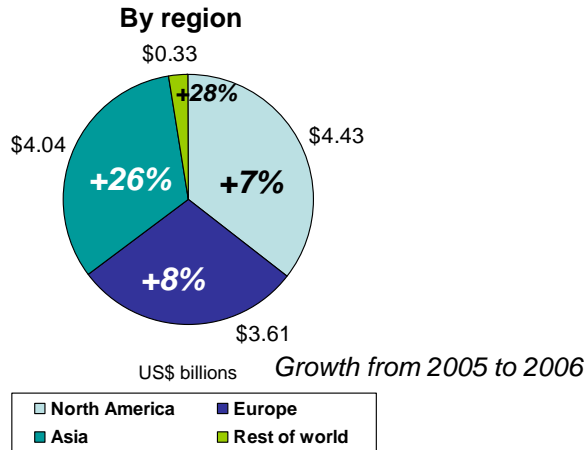


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## Nanotech funding reached \$12.4 billion in 2006



Sources: Lux Research Reference Study "The Nanotech Report, 4<sup>th</sup> Edition"; Lux Research Reports "How Industry Leaders Organize for Nanotech Innovation"; "Ranking the Nations: Nanotech's Shifting Global Leaders"; "Making Sense of Nanotech Venture Capital"



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## Nations must perform on two distinct axes to dominate in nanotechnology

Nanotechnology activity		Technology development strength	
Nanotech initiatives	15%	R&D spending as % of GDP	25%
Nanotech centers	15%	High-tech manufacturing as % of GDP	20%
Nanotech publications	15%	Technology and science workforce	20%
Issued U.S. patents	15%	Science and engineering Ph.D.'s	15%
Government spending	10%	Expatriation of educated	10%
Risk capital	10%	Infrastructure	10%
Corporate R&D	10%		
Active companies	10%		

**Absolute scale**

**Relative scale**

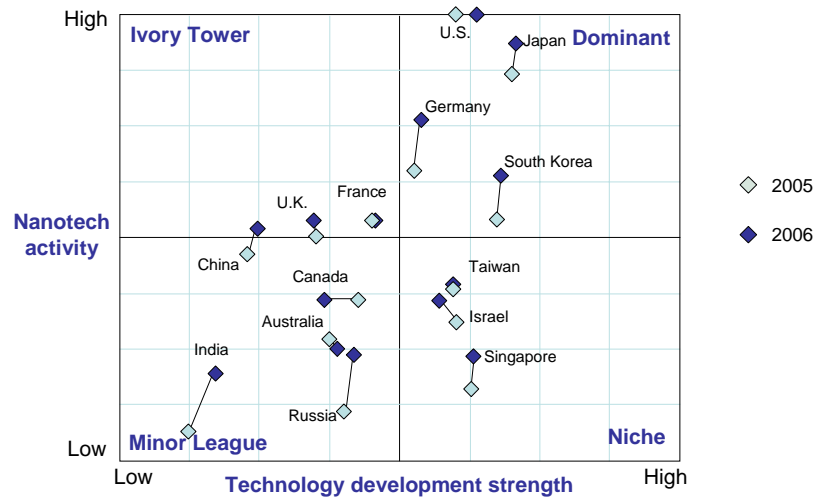


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## Top nations in nanotech see their lead erode



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## How can the U.S. solidify its position?

- Shift some funding to the commercialization challenges like scale-up, IP processing, and EHS studies
- Create forums and incentives to connect technology developers and end users
- Alleviate real and perceptual risks by accelerating progress on regulation
- Address workforce issues by increasing H1B visas



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## Thank you

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