CoreNet Global Section Québec

Québec Chapter

February 13, 2008

Nanotech Materials for Truly Sustainable Construction

Speakers:

David Sykes

Founder, NanoNexis; Managing Director, Remington Partners

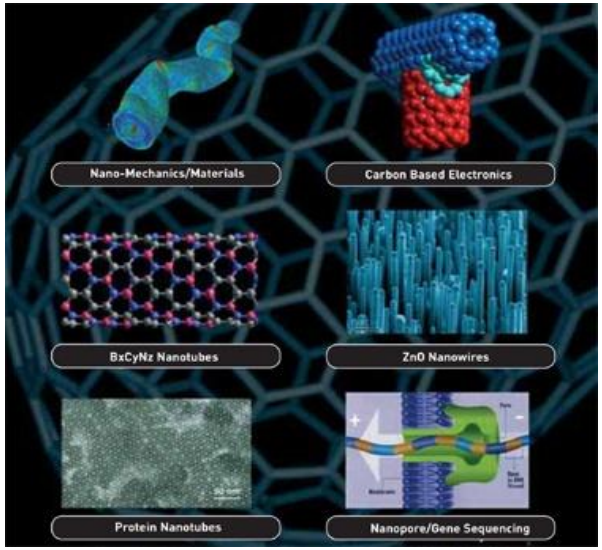
R. J. Brennan, MSC, LEED® AP

Associate, Director Strategic Workplace, IA Interior Architects

President, CoreNet Global Chicago Chapter

*"The time to start watching how companies are investing in and deploying nanotech won't come in some distant future . . . that time is **now!**"*

Lux Research



Nanotechnology

- First described 24 years ago

- Manipulating individual atoms
- Smaller than “micro”
  - *a nanometer is one billionth of a meter*
- A revolution in building materials

- Important as part of 3BL
  - *The “sustainable buildings” initiative*
  - *High “performance” workplaces*

Three Questions:

- Do you assume “going green” adds to your first cost?
- Can you name 3 nanotech base building materials?
- How will nanotech enhance the building stock?

Five Segments

1. Context
2. The revolution in building materials
3. How to integrate nano-materials with business goals
   - *Case study #1: office work environment*
4. Current “green” nano-material example: aerogel
   - *Case study #2: Base Building Design*
5. Next steps, resources & contacts

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1. Context

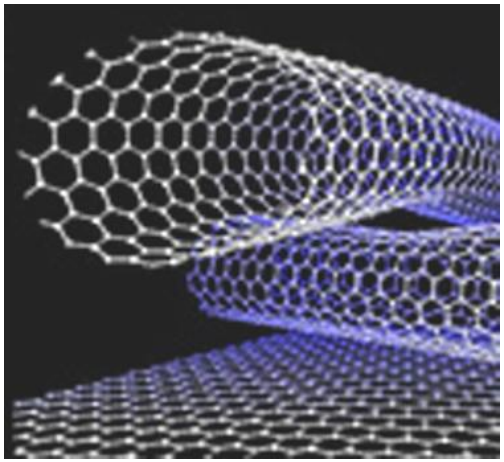
CRE is a big target

- 60% of global industrial waste is from the construction and demolition of buildings
- 60% of electrical use in developed nations is by buildings
- 40% of total energy consumed is by buildings

What is Nanotechnology?

What is it?

- Nano is Greek for “dwarf”
- Manipulation of matter < 100nm
- (1 10,000th the size of a bacterium)
- 80,000X smaller than a human hair
- Revolution began 47 years ago

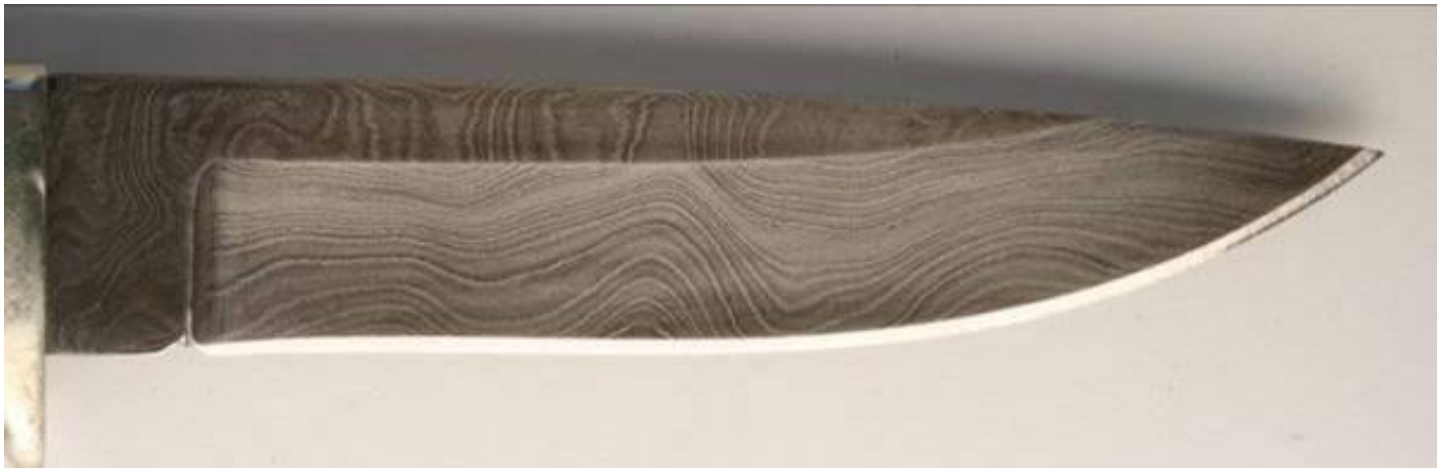


Why now? We can do it!

- Tools are available
- Global competition (Asia vs. Europe vs. North America)
- $10 billion global investment
- Real, useful products are already here
- Useful response to global climate change

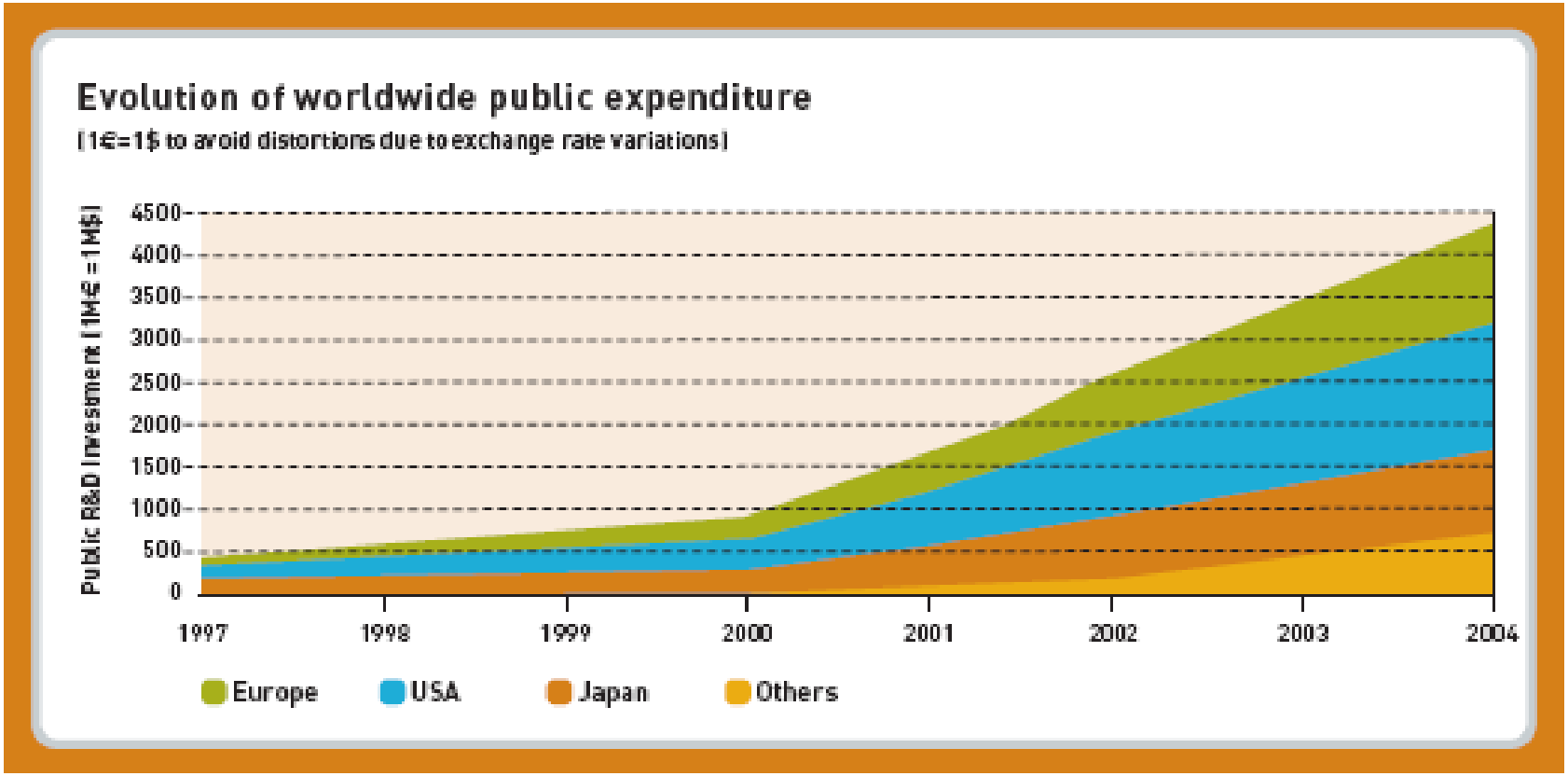
Old or new? (Damascus 900-1750AD)

Arms race? The first crusaders encountered better steel

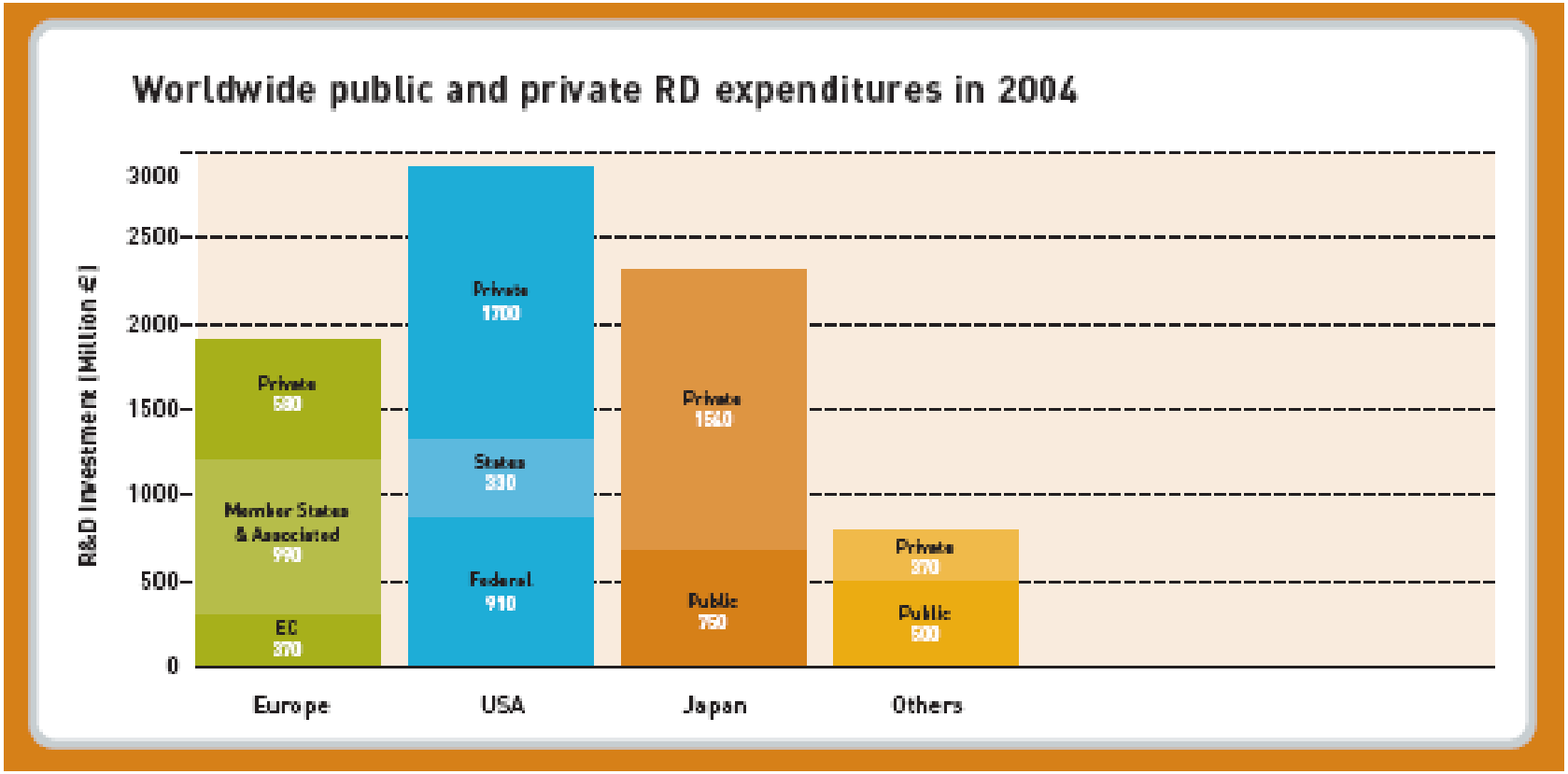


- Wootz steel, developed in India & Sri Lanka ~300 BC
- greater strength & flexibility due to carbon nanotubes
- technique lost ~1750AD

Tipping point was 2000



R & D nano spending in 2004



22 US Federal Agencies...

- USDA
- DOD
- DOE
- DHS
- DOJ
- EPA
- NASA
- NIST (DOC
- NIOSH (DHHS)
- NIH (DHHS)
- NSF
- DIS (DOC)
- CPSC
- DOS
- DOT
- DOTreas
- FDA (DHHS)
- ITC
- IC
- NRC
- TA (DOC)
- USPTO (DOC)

2006: Seven Program Component Areas

1. Fundamental nano-scale phenomena & processes ($234 mil)
2. Nano-materials ($228 mil)
3. Nano-scale devices and systems ($244 mil)
4. Instrumentation research, metrology, and standards for nano-technology ($71 mil)
5. Nano-manufacturing ($47 mil)
6. Major research facilities & instrumentation acquisition ($148 mil)
7. Societal dimensions ($82 mil)

Bi-partisan

"21st Century nano-technology R&D Act" (Public Law 108-153, 2003)

Private Investment

- In 2005, 1331 companies in 76 industries invested $3.2 billion in nano-technology and sold $32 billion in products incorporating nanotechnologies
- Expect $12 billion private investment by 2008
- Example: One of CEO's top 3 priorities at GE; spent $50 million in 2005 (1.5% of R&D budget)
- VC's have spent $2 billion on 143 known startups
- Governments & corporations spent 19 times more

Source: Lux Research

Does it Matter to CRE?

Yes!

- You will not get the “green” gains you need
  - energy savings
  - higher performance
  - lower costs

  unless you insist that architects, specifiers and contractors look seriously at nano-materials (see the CoreNet 2010 Report)

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2. The Revolution in building science

A quick overview

Put on your running shoes…

- Steel
- Concrete
- Glass
- Gypsum Drywall
- Fabrics & Carpet
- Energy/HVAC
- Filtration
- Electronics / Sensors
- Tools
- Coatings & Paints
- Lighting
- Insulation

Steel

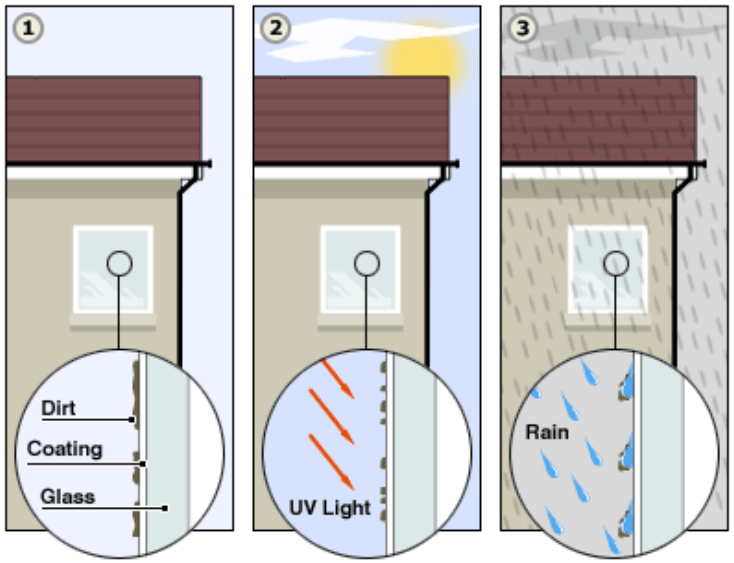
- Nanocomposite steel is available & stronger (per ASTM)
- Withstands temperatures as low as -140F
- Increased plasticity
- Free of corrosion-causing carbide paths
- Results:
  - reduced amount of steel
  - Simplified placement of structural concrete
  - 20 to 40% savings

Concrete

- Production of concrete accounts for 8% of total CO_2 emissions worldwide
- Translucent concrete?
- Cool idea by Dutch Architect, Rem Koolhaas

Glass

- Can block UV & glare
- Self-cleaning glass coated (titanium dioxide coating breaks down organic matter



Switchable Glass

Gypsum Drywall

- Nano-drywall is lighter, stronger and water resistant

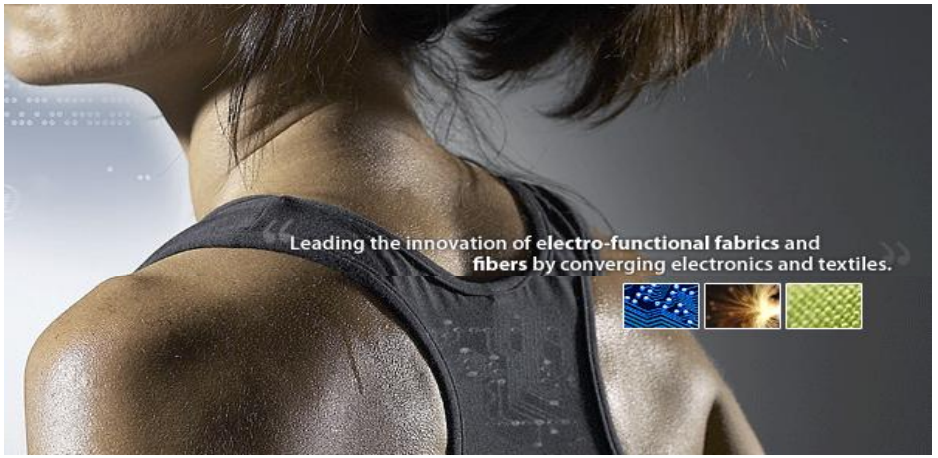
Fabrics & Carpet

- Nano-treatments are used on commercial fabrics
- Color-fast, stain proof and dirt proof
- Naturally hydrophobic, no mold or mildew

ArcCom Architex Carnegie

DESIGN TEX Douglass Dreamland

heavenly foam KLEARVU KnollTextiles

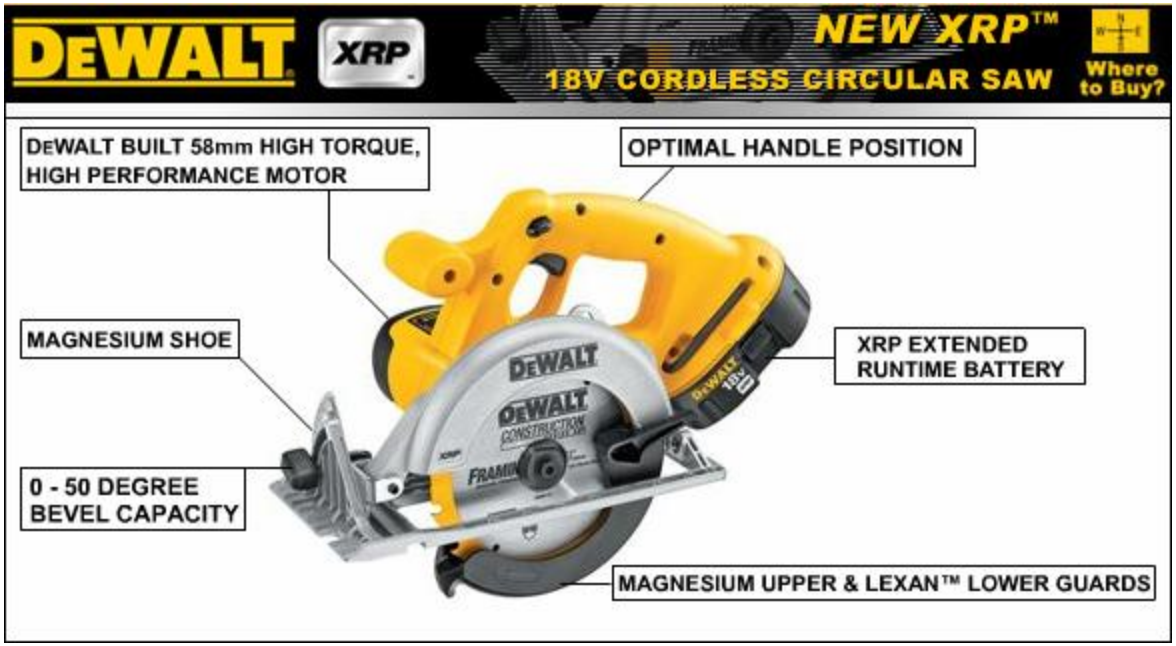


Energy / HVAC

- Solar cells infused with nano-technology are thin, flexible and come in rolls so they can be applied as roofing material

Tools

- Doped Nanophostate Lithium Ion batteries
- Cordless tools are more powerful than corded!



Coatings & Paints

- Nano particles enhance physical and aesthetic qualities
- Hard, durable finish
- Excellent water resistance
- Scrub-ability
- Stain blocking and other properties

Lighting

LEDs (point source) & OLEDs (sheet)

- 40% of commercial energy goes to lighting
- LED is most efficient, sustainable solution
- 10X more efficient than incandescent
- 50,000 - 100,000 hours (vs 10,000)

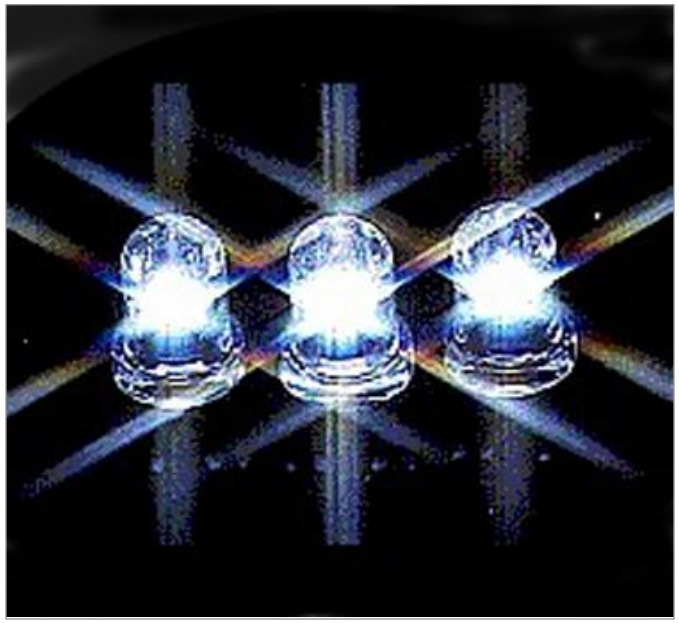
"No other lighting technology offers so much potential to save energy and enhance the quality of buildings"

U.S. Dept. of Energy

Solid-state lighting

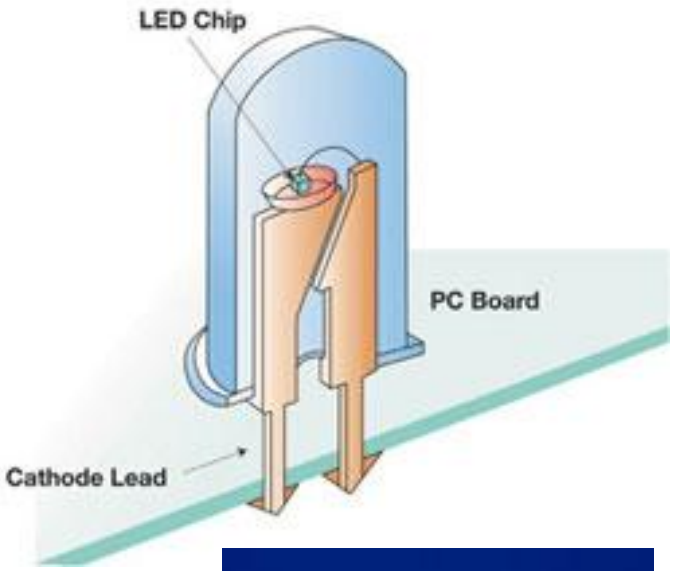
Big technology push

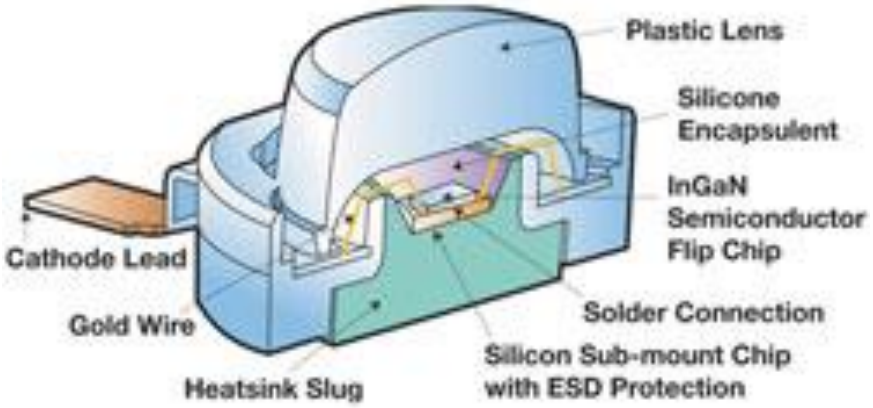
- 46% average annual growth from 2001-4
- HB LED market $4.2 billion in 2006
- Growing to $9.9 billion in 2011

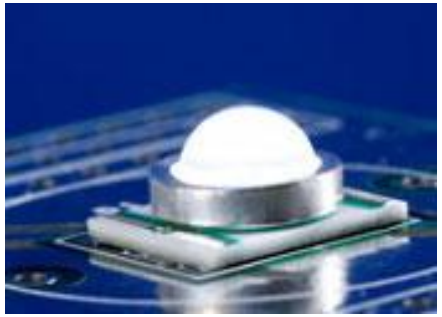


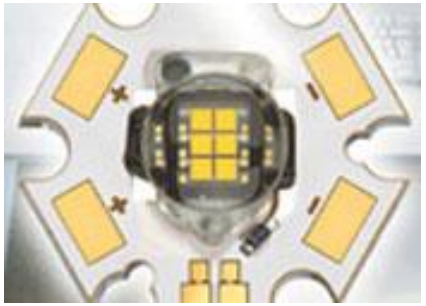
**Examples: Osram, Philips, OptiLED Holdings (Hong Kong)*

Solid-state lighting



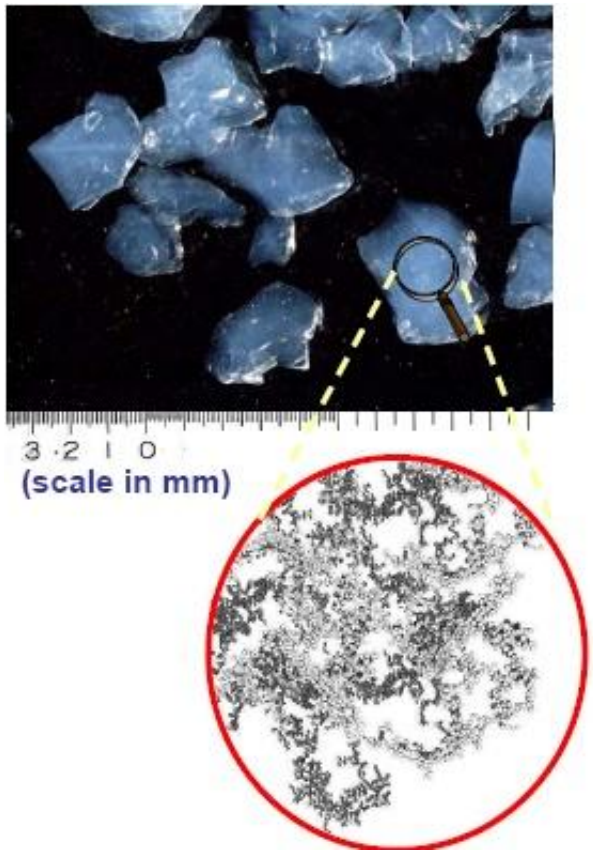






Insulation

- Aerogel, a translucent thermal-acoustic insulator
- Looks like frozen smoke
- Best insulating solid in the world
- Weighs only 90 grams per litre
- Extremely flexible
  - blankets, beads, sheets



*The new "plastic"**

**Not really—it's amporphous silica (sand)*

How to use these innovations?

- Steel
- Concrete
- Glass
- Gypsum Drywall
- Fabrics & Carpet
- Energy/HVAC
- Filtration
- Electronics / Sensors
- Tools
- Coatings & Paints
- Lighting
- Insulation

Questions?

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3. Integrating new materials with business goals: a case study

Integrating nano into CRE

A comprehensive stage-gate method . . .

Three premises:

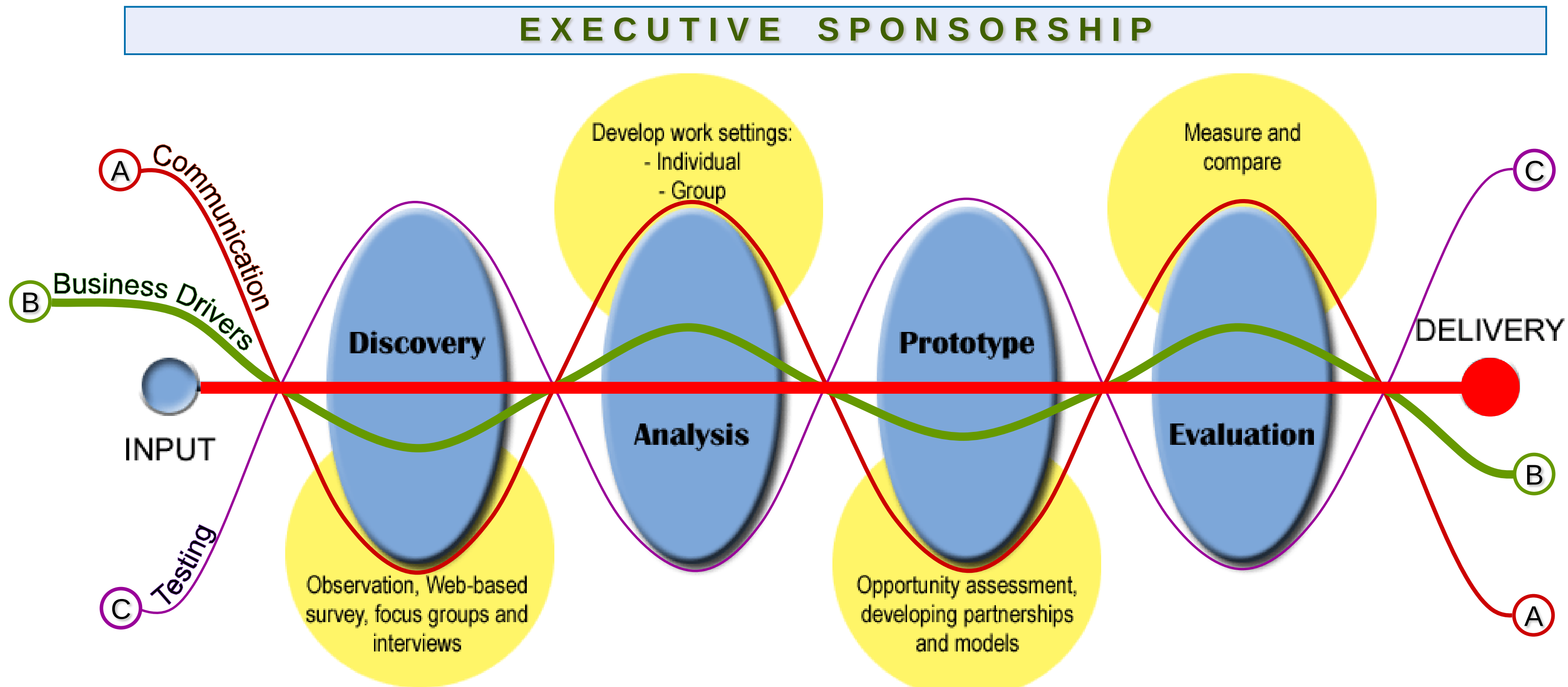
- Incremental change is best – limits risk
- Must solve real business problems; data-driven
- Teamwork is essential

Nine rules for supporting extensive change

1. Secure early **senior executive buy-in**
2. Identify **significant needs better sol**
   - *e.g., "Privacy without walls" is require Oxley, GLBA, HIPAA, Patriot Act, etc.*
3. Look for tax **incentives** & governmen
4. Work with authoritative **resources**
5. **Collaborate** with manufacturers
6. Manage risk – Do **prototyping & tes**

Team well…plan carefully…execute thoughtfully

7. Use an **integrated process** (e.g., IA SmartSpace^{SM})
8. **Measure results** – quantitative and qualitative
9. **Manage change** – communicate



Case Study #1: Solve a real problem

Business problem: noise & privacy in open plan offices

- **Privacy & security laws**, are **not compatible** with open-office landscapes (intended to encourage teamwork & maximize natural light)
  - How to meet the growing international need for **privacy without building walls** or abandoning open offices?
- **Leading sources of dissatisfaction** from GSA Post-Occupancy Assessment of Speech Privacy in Offices:
  - People talking nearby…….. **92%**
  - People talking on the phone…… **84%**
  - People overhearing private conversation….. **82%**

Sources to which dissatisfaction with acoustics was attributed

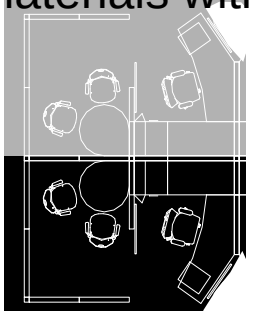
Presented by Kevin Powell of GSA and Charles Salter and Randy Waldeck of Charles Salter Associates on June 4, 2007, at the 153rd Meeting of the Acoustical Society of America in Salt Lake City, UT

Why Use a Nanomaterial?

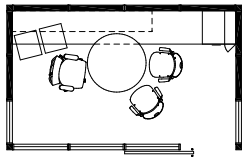
- Conventional materials are **not optimal**
  - Need enhanced acoustic value
  - Need thinner material, less bulk
  - Need translucency
  - Need enhanced thermal value
  - Need lighter weight
- Can a nanomaterial solve the problem?
  - Are there **risks**?
  - Do the enhanced performance characteristics provide **new opportunities**?
  - Where can one locate the materials and manufacturers?

One Solution: ISOPods™

Deliver privacy without construction using light weight, furniture components & translucent nanomaterials with acoustic properties

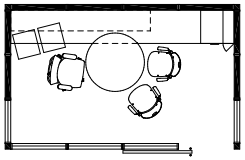


Single ISOPod™



Double ISOPod™

Installed: flexible, daylight, acoustic

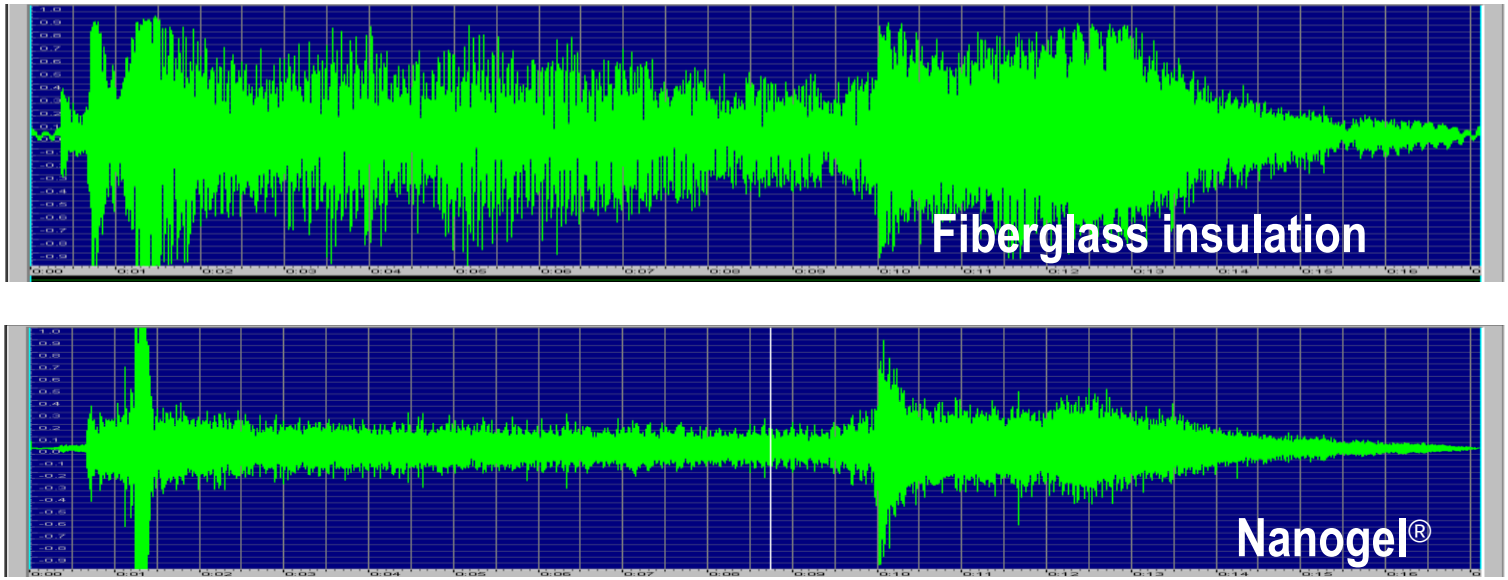


Sound Transmission: Acoustic Performance

Truck Noise

10 db attenuation 40 - 400 HZ sound transmission

loss 2-3/4” FRP



Sound pressure level vs. time

What is a winning approach?

- Communicate – a **thorough discovery phase** supports business process and enhances individual work styles
  - Understand and document the desired outcomes, assess goals
- **Consider all elements** of the integrated solution – built, cultural, etc.
- Teamwork is critical – **get the right players**!
  - Client
  - IA Interior Architects (Strategist/Architect)
  - Component Manufacturer
  - NanoNexis (Subject Expert)
  - Supplier of Nanomaterial
- Assess and communicate the results – **test**
- **Make adjustments** – communicate what was changed and why

"So what do I do with all this information?"

"What does it mean to me??"

- Be **clear on the goal**, as well as the risk vs. reward factors, of incorporating new technologies into an initiative
  - If anything goes wrong, it's always the new stuff!
  - It is up to the Client, not the architects/designers/contractors, to insist on exploring these new technologies!!
- The bottom line is that nanotech materials can **significantly enhance performance**, as well as increasing the "greenness" of any given project . . .
  - Widespread adoption is still some time away
  - USGBC does not yet have an official stance on these materials
  - **Manufacturers need direction** on what products to enhance
  - You can help define what will be available!!

Questions?

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4. Example of a “green” nano-material: aerogel insulation and glazing

About aerogels

- Well-known, insulating nano-substance that is translucent and 97% air
- Nanogel™* panels – developed for skylights – fit ISOPod™ concept:
  - Lightweight
  - Hydrophobic
  - Highly translucent
  - Thin
  - Superb thermal / acoustic insulator
  - Manufactured as large, rigid panels

* Manufactured in Frankfurt by Cabot Corp.

Uses in CRE?

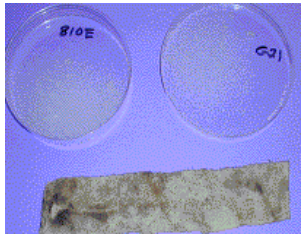
- Aerogels have multiple uses in interior & exterior construction
- Green certification? Earn points by incorporating natural daylight as an energy conservation features
- Earn more points for improved acoustics

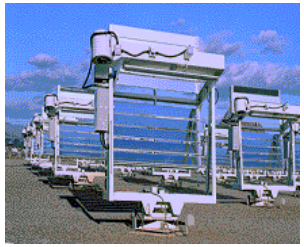
Heat, Light, & Noise

Thermal Performance

- R-20 The insulating value of a 6” stud wall

nanogel™ TRANSLUCENT AEROGEL





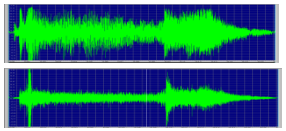
Testing

Permanence of performance

- Non-combustible/ no smoke
- Mold/mildew resistance
- Condensation resistance
- UV Stable

Noise

- 50% Sound Reduction



More about Aerogels

- Nanomaterial known since 1931
- Used extensively in aerospace
- Nanogel™ is a proprietary form of “aerogel”
  - skylights
  - exterior glazing
  - pipeline insulation
  - apparel
  - medical devices

$$k_{aerogel} = k_g + k_s + k_r$$

More about Aerogels

- Nanogel used across North America & nine European countries
- Not an experiment!
- Cabot is 125 years old, a $2.9 billion public company
  - 21 countries
  - 36 manufacturing sites
  - 8 R&D facilities

Examples – Skylights

Case Study #2

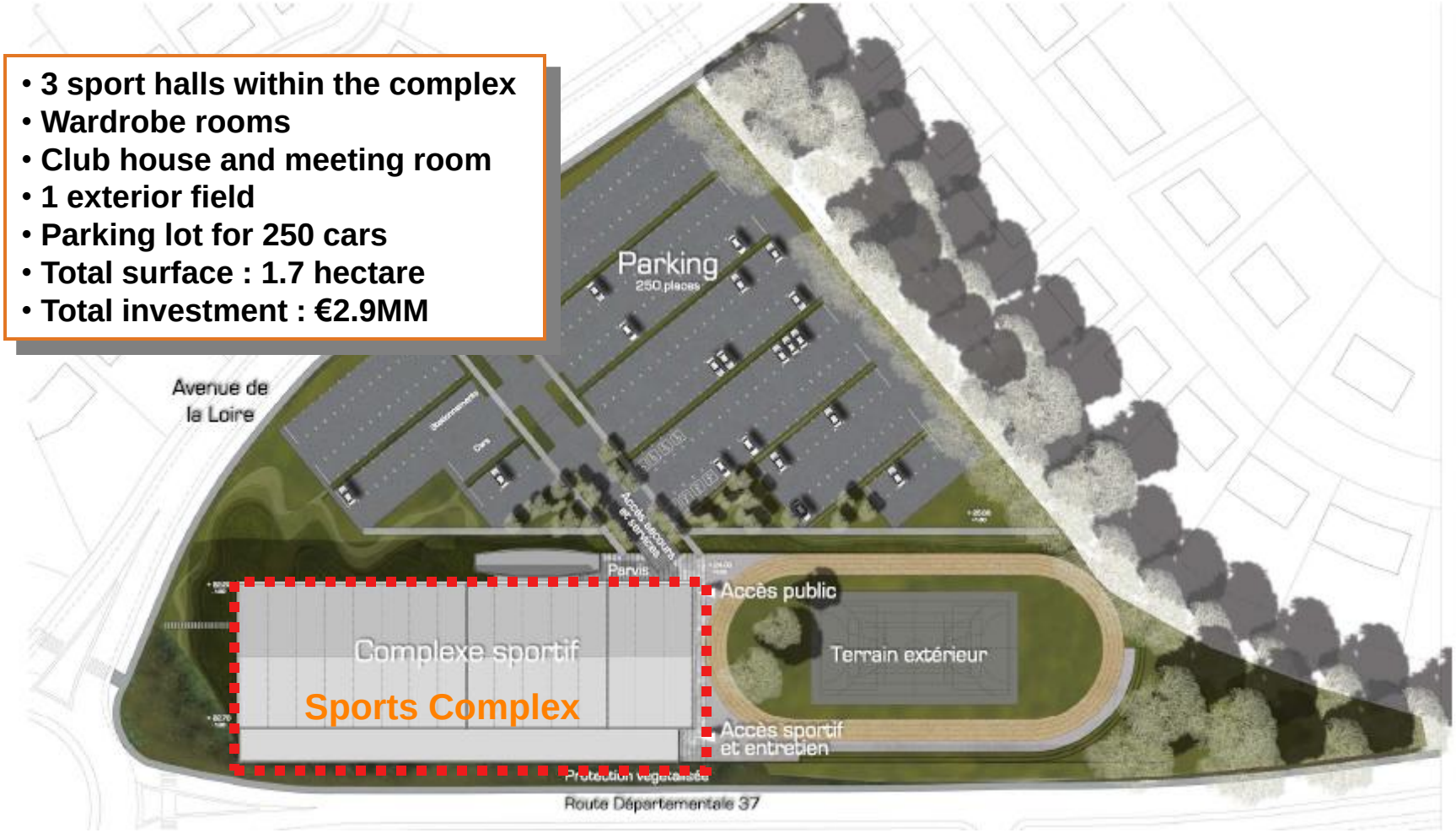
Sports Complex of Souchais, Carquefou, France

- Owner: City of Carquefou
- Architect : MA Murail Architectures, Nantes & Paris, France
- Contractor (façade) : Belliard

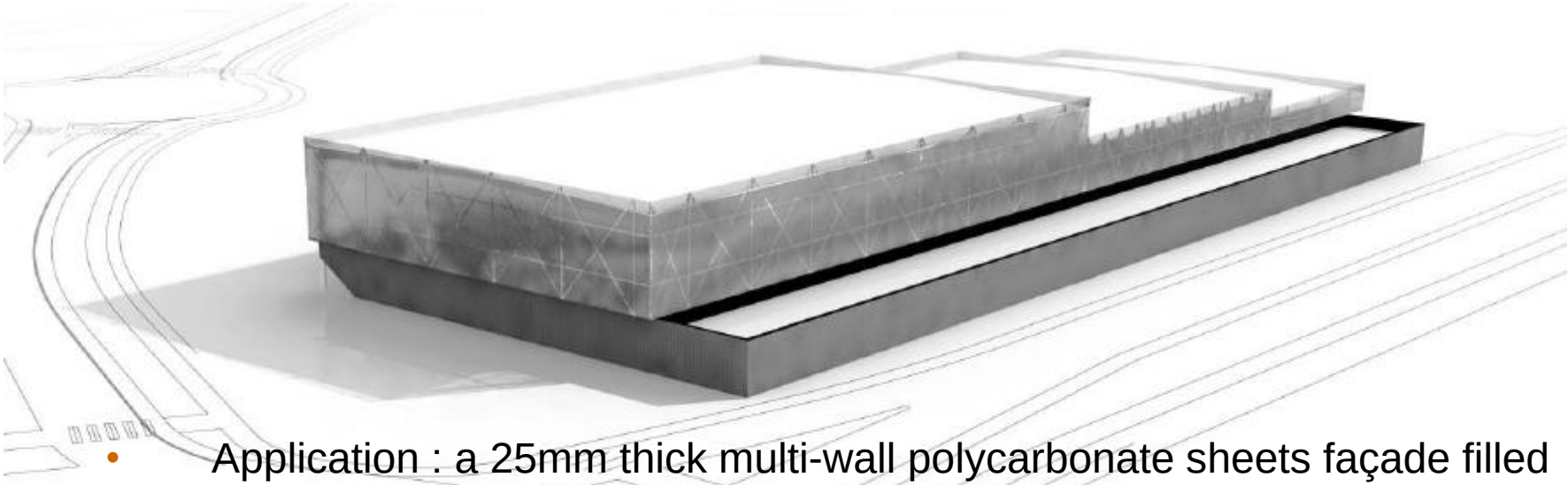
MURAIL ARCHITECTURES

Goal

- 3 sport halls within the complex
- Wardrobe rooms
- Club house and meeting room
- 1 exterior field
- Parking lot for 250 cars
- Total surface : 1.7 hectare
- Total investment : €2.9MM



Goal



- Application : a 25mm thick multi-wall polycarbonate sheets façade filled with nano-material
- (Total surface of 1450m2) on the whole perimeter of the building (surface of 3360m2).
- The façade had to meet a thermal insulation value < 2.7 W/m.K
- The nano-material allows to achieve a value of 0.89 W/m.K

Options

- Shaders were not an option : very costly, heavy structure, not in line with the architect's concept of a smooth building surface

Cost comparison

Nano-Materials (aerogels) applied to the Building Industry

Nano-material Solution + Polycarbonate

• Polycarbonate sheets :	€100/m²	€145,000
• Nano-material cost :	€67/m²	€ 97,000
Total cost	€167/m²	€242,000
Energy savings		€3000/year on lighting €2000/year on heating

Versus Double-pane Glass

• Glass, profiles :	€300/m²	€435,000
• Shaders	€130/m²	€188,500
Total cost	€430/m²	€623,500

Savings
€263/m² €381,350
Immediate payback
+ €5,000/year on energy

Versus PC without nanomaterial

• Polycarbonate sheets :	€100/m²	€145,000
• Shaders	€130/m²	€188,500
Total cost	€230/m²	€333,500

Savings
€63/m² €91,500
Immediate payback
+ €5,000/year on energy

Results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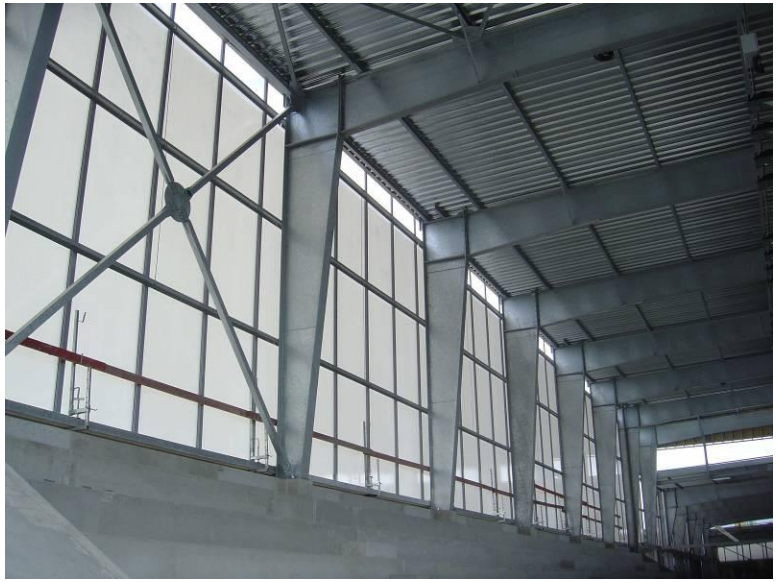
Results



Natural daylight evenly dispersed inside the building
No glare, no shadow, no “light tunnel” issues
High comfort level for the players and spectators

Questions?

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5. Next Steps, resources, contacts

Resources

- *Material Connexion*, Beylerian & Dent (Wiley, 2005)
- *Material Architecture*, Fernandez (Oxford, 2006)
- *EU Nanoforum Report* (December 2006; nannoforum.org)
- *Transmaterial*, Brownell, (Princeton, 2006)
- *Material World 2*, MateriO (Birkhauser, 2006)
- *Extreme Textiles*, McQuaid (Princeton, 2005)
- *The Dance of Molecules,* Sargent (Penguin, 2006)
- *The Nanomaterials Handbook,* Gogotsi (CRC, 2006)

The future of CRE is here now

"Because of nanotechnology, we will see more change in our civilization in the next thirty years than we did during all of the 20th century"

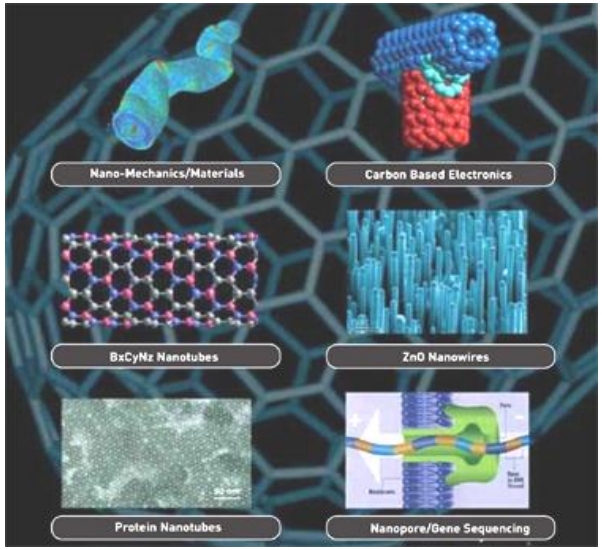
- M. Roco, National Science Foundation

A new way of thinking

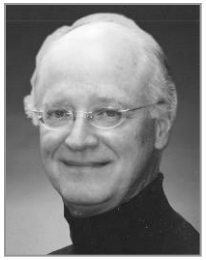
- Photocatalytic cement with TiO_2
- Self cleaning (Rome, 2003)
- Removes pollutants in area around building (CO_2, NO_2, etc.)

*"The time to start watching how companies are investing in and deploying nanotech won't come in some distant future . . . that time is **now!**"*

Lux Research



Contact Information



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