The New Steel? Enabling the Carbon Nanomaterials Revolution:

**Markets**, Metrology, Safety, and Scale-up

*Frost & Sullivan’s Study on Potential Market for Carbon Nanomaterials’ Applications*

February 28, 2011
Nanomaterials in Composites, Textile and Coatings
Market Applications for CNTs in Composites, Textile, and Coatings

Nano Materials

Composites
- Electrostatic dissipation
- Electromagnetic shielding
- Structural reinforcement

Textiles & Fibers
- Smart textiles
- Reinforcement & protection
- Electrostatic dissipation
- Electromagnetic, RF, and microwave shielding

Coatings
- Marine antifouling coatings
- Intumescent coatings
- Protective coatings
- Antimicrobial coatings

Source: Frost & Sullivan Research
Global Addressable Market for Carbon Nanotube (CNT) based Composites was $18.79 billion in 2008

For US Market Alone

- Construction Applications, 45.0%
- Marine, 20.0%
- Transportation, 12.0%
- Corrosion, 12.0%
- Consumer Products, 5.0%
- Electrical, 4.0%
- Aircraft and Others, 2.0%

Rest of the World, 3.0%
North America, 40.0%
Europe, 35.0%
Asia-Pacific, 22.0%

Significant growth rates are seen in aerospace & defense, automotive, and construction, within a general industrial rate of 3% to 7%.  

Source: Frost & Sullivan Research
CNTs will penetrate about 3.6% within vehicular composites. If 1% carbon nanotubes are loaded into these materials, this means a CNT market for automotive composites of $35.52 million.

Source: Frost & Sullivan Research

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Carbon nanotubes are forecast to begin penetrating construction materials in the current year through 2012, and could penetrate up to 10% by 2015 if nanotech developers can prove and validate their products’ ability to reinforce structures.

Source: Frost & Sullivan Research
Frost & Sullivan expects penetration of CNTs in this area to commence in 2012, and could reach up to 15% by 2015.
CNT Market Estimation for Coatings (2009-2015) - Frost & Sullivan projects that CNTs could penetrate up to 25% of the intumescent coating market by 2015 and 2% penetration rate for antifouling coatings also by 2015 at 1% loading rates.
Electronics
Market Applications for CNTs in Electronics

- **CNT-based Electronics**
  - **Circuits & Processors**
    - Interconnects
    - Transistors, memory, logic
    - Thermal interface materials
  - **Displays/Flexible Displays**
    - FPDs, TFTs (electrodes or conductive inks), electron emitter
    - Backlight
    - Signage
    - Touch screens/panels
  - **Flexible/Printed Electronics**
    - Memory/logic
    - RFID
    - Sensors
  - **Sensors**
    - Chemical, gas, bio sensors
    - IR sensors
    - DNA sensors

Source: Frost & Sullivan Research
Market Analysis For CNT in Electronic Sub-Segments

Total global market size for the semiconductor IC market (2008-2015)

- CNT Interconnects: Nil to 1% - 5%
- Logic and memories: Nil to 1% - 2%

Total global market size for the display market (2008-2015)

- Displays: Nil to 1% - 5+%
- Flexible Displays: Nil to 1% - 10%

CNT penetration potential

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Market Analysis for CNT in Sensors - Expected Penetration Rate of CNT in these Addressable Markets is 1%

Global market size for the chemical, gas and bioagent sensors in homeland security market (2008-2015)

Global market size for the chemical, gas and bioagent sensors in medical diagnostics market (2008-2015)

Global market size for the chemical, gas and bioagent sensors in industrial/industrial safety market (2008-2015)

Total global market size for the infrared sensors market (2008-2015)

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Source: Frost & Sullivan Research
Market Summary for CNTs in Electronics

CNT penetration potential

- CNT penetration in the various sensor applications: Likely to be not greater than around 1% during the forecast period (2008-2015)
  - Promising markets- interconnects, displays/flexible displays, chemical/gas and bioagent sensors: CNTs will begin to penetrate by around 2014 or so (within around five years).
  - Other markets - memory, transistors/logic, infrared sensors, DNA sensors, flexible electronics: CNT might take longer time to penetrate.
- CNTs are expected to have a minor share (e.g., ranging from less than 1% up to possibly 5%) of the overall available market in each aforementioned application segment over the forecast period (through 2015).

Source: Frost & Sullivan Research
Authentication
Market Applications for Nanomaterials in Authentication Segment

Nanomaterials in Authentication

Pharmaceuticals
• Anti-counterfeiting of drugs

Government issued Documents and Currencies
• Passports
• Drug Prescription forms
• Currencies
• Driver's licenses

Biometrics
• Fingerprinting technologies
• Nano sensors
• DNA Analysis

High-end Luxury goods
• Watches
• Shoes
• Bags
• Clothes

Source: Frost & Sullivan Research
Authentication Segment Market Analysis and Forecasts - Nanotechnology may represent about 1-5% of the total authentication market in the forecasted period.

CAGR = 12%


- The total counterfeit market: US$295 Billion annually
- Counterfeiting of technology products represent about $100 billion, pharmaceutical drugs at $40 billion dollars
- Music piracy, airline parts, and mobile phone entertainment make up the 51% of the total

Counterfeit Products Market (% of total market annually)

- Other, 50.92%
- Pharmaceutical Drugs, 33.90%
- Shoes, 0.31%
- Currencies, 0.02%
- Purses, 0.02%
- Clothing, 2.80%
- Alcohol, 0.10%

Source: Frost & Sullivan Research

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