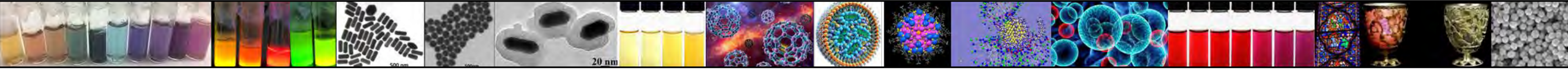

NANOTECHNOLOGY CENTER

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Founding Director

Center for Nanotechnology

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https://www.coppin.edu/research/center-nanotechnology

What is Nanotechnology?

- Nanotechnology = science, engineering, and technology conducted at the nanoscale. (Including atomic, molecular or macromolecular levels)

- Structures, devices and systems = with new properties & functions due to reduction in size

- Capacity to control or manipulate matter on the atomic scale

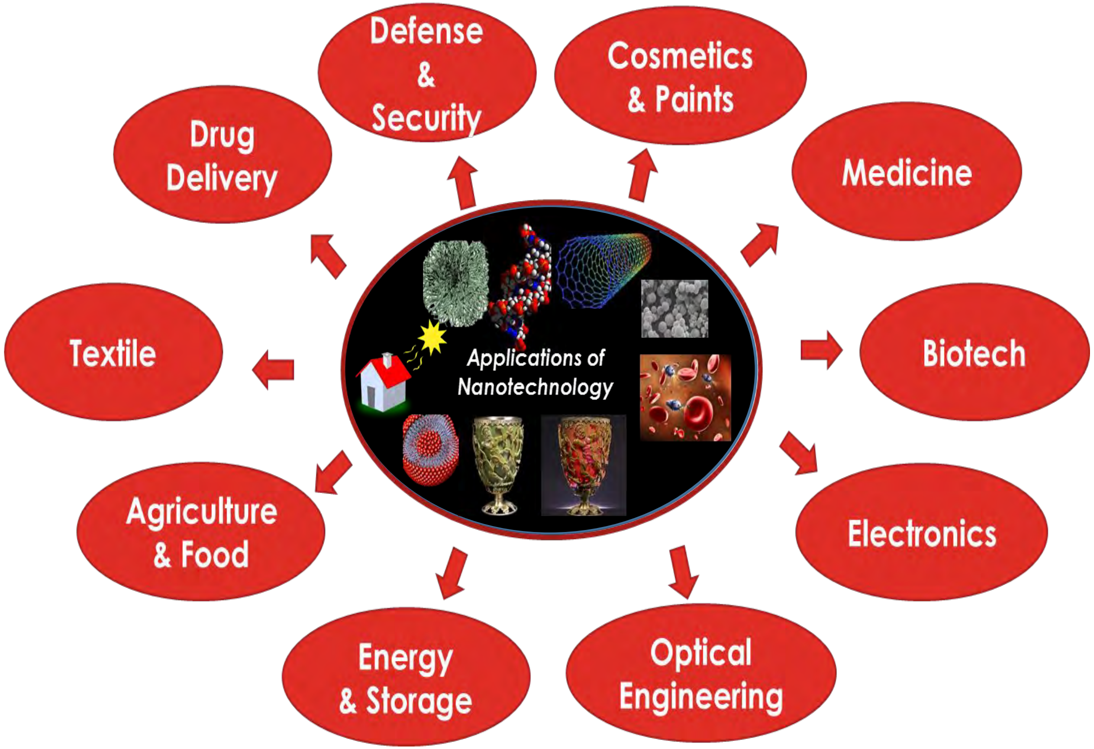
Why do we care about nano?

Physics is different on the nanometer scale

Properties not seen on a macroscopic scale now become important

You work with individual atoms & molecules rather than bulk materials

APPLICATIONS OF NANOTECHNOLOGY



EVERYDAY PRODUCTs

Shoe Sprays, Scratch resistant sunglasses, Polyethylene terephthalate (PET) bottles, Clothing

Nano titanium dioxide spray product

Nanotechnology offers scratch resistant coatings based on nano-composites and anti-fog coatings for enhanced visibility

Nanotechnology in clothing has been its ability to create dirt repellent fabrics.

When clay nanoparticles are put into plastics, the plastic forces the clay platelets apart and gives a much larger exposed surface area which enables the strength of the plastic to be retained when less of it is used.

EVERYDAY PRODUCTs

Television screen, Mobile phones, Laptops, Frying pans, Cleaning Products, Cosmetics

Samsung QLED is a quantum dot based TV

NanoBond™ surface is a proprietary blend of alloys including titanium, creating a highly strong, resilient and lasting finish.

Hestan NanoBond™ Stainless-Steel Skillet

New Smartphone Battery Recharges in 30 Seconds Flat: Using Quantum Dot Technology and also Graphene

Materials such as Graphene, Carbon nanotubes and nanowires are expected to be used in charging laptops

Using nanomaterials in the cleaning process that are antibacterial, such as silver nanoparticles.

Liposomes and niosomes are used in the cosmetic industry as delivery vehicles.

Instrumentation used in Nanotechnology

Acknowledgment

- E2- ENERGY TO EDUCATE GRANT PROGRAM (163893)
- GRANT AMOUNT - $575, 000.00

- DEPT. OF EDUCATION, SAFRA TITLE III GRANT
- GRANT AMOUNT - $ 800, 000.00

- MIPS GRANT
- GRANT AMOUNT - $100,000.00

- NSF PLANNING GRANT
- $100,000.00

- NSF EiR (BEING SUBMITTED)
- $500,000.00

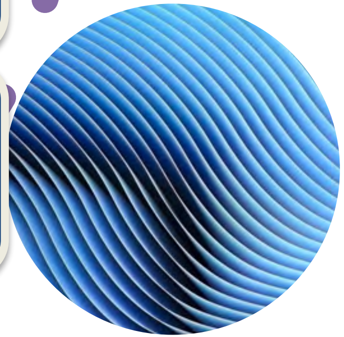
- DEPT. OF ENERGY
- $2,175,000.00

Artificial Intelligence in Nanotechnology

THE FUSION OF INTELLIGENCE AND PRECISION AT THE NANOSCALE

DR. WILLIAM E. GHANN/DR. JAMAL UDDIN
CENTER FOR NANOTECHNOLOGY

DATE : 10/01/2025



Introduction

Nanotechnology

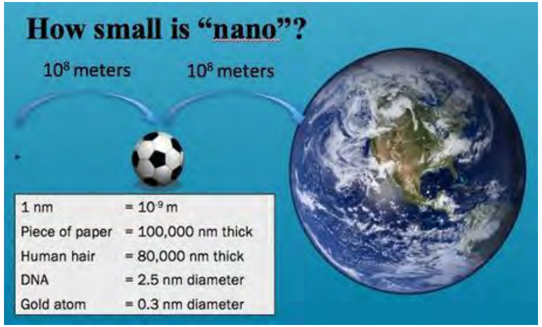
❖ Manipulating matter at the nanoscale

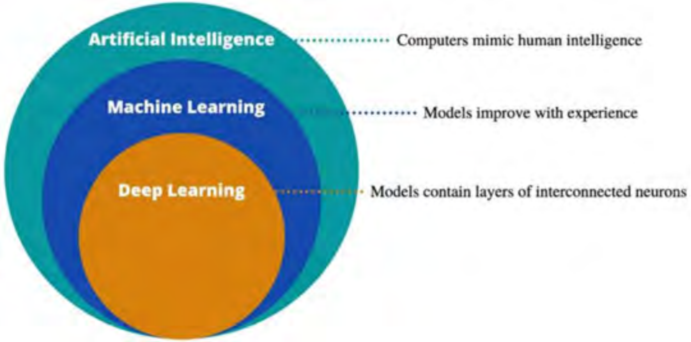
Artificial Intelligence

❖ Simulating human intelligence through machines

Combined power or Synergy

❖ Intelligent design and analysis at nanoscale using AI to guide, optimize, and analyze nanoscale experiments





Role of AI in Nanotechnology

Data Analysis:

•AI models interpret UV-Vis, XRD, SEM, and PL spectroscopy datasets

Pattern Recognition:

•AI distinguishes nanoparticle morphologies from SEM images

Optimization:

• Guides synthesis of stable and uniform nanomaterials

Predictive Modeling:

•Anticipates material behavior in biomedical or energy applications

- DATA ANALYSIS AT NANOSCALE

- PATTERN RECOGNITION IN IMAGING

- OPTIMIZING SYNTHESIS

- PREDICTIVE MODELING IN MEDICINE

Role of AI in Nanotechnology (Advanced Data Analysis)

Challenge: Interpreting large datasets from spectroscopy and microscopy tools can be time-consuming and prone to human error.

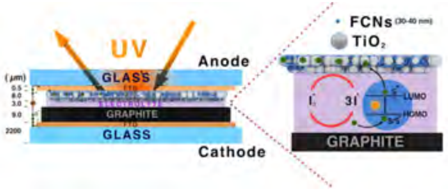
AI Solution:

Machine learning algorithms can rapidly analyze data from UV-Vis, photoluminescence (PL), and Fourier-transform infrared (FTIR) spectroscopy.

AI tools extract key features (e.g., absorbance peaks, and band gaps) with higher accuracy and speed.

Application at the center for nanotechnology:

Students working on carbon nanoparticles for solar cells can use UV-Vis and PL data; AI models help determine quantum efficiency and emission profiles faster and more consistently



Role of AI in Nanotechnology (Pattern Recognition in Imaging)

Challenge: Identifying subtle morphological differences in nanoparticles using SEM or AFM images requires expertise.

AI Solution:

Deep learning and convolutional neural networks (CNNs) classify and quantify nanoparticle shapes, sizes, and distribution.

Reduces subjectivity and accelerates material characterization.

Application at the center for nanotechnology:

In silver nanocube and electrospun fiber projects, AI can assist in measuring fiber diameter, uniformity, and detecting defects from SEM images—making data analysis more accessible for undergraduate researchers.

Role of AI in Nanotechnology (Synthesis Optimization)

Challenge: Synthesizing nanomaterials involves tuning multiple parameters (e.g., pH, temperature, precursor ratios).

AI Solution:

Supervised learning models and neural networks predict outcomes based on historical experimental data.

AI provides synthesis recommendations to achieve optimal yield, stability, and reproducibility

Application at the center for nanotechnology:

In the synthesis of biochar-nanocomposites for water treatment, AI could optimize activation conditions and doping ratios for maximum adsorption efficiency.

Role of AI in Nanotechnology (Predictive Modeling for Functional Performance)

Challenge: Experimental testing of every material variation is resource-intensive.

AI Solution:

Models trained on known data can predict how nanomaterials will behave in energy, biomedical, or environmental systems.

Supports inverse design, where desired properties are specified and AI suggests the best material composition or structure.

Role of AI in Nanotechnology (Predictive Modeling for Functional Performance)

<u>Examples at the Center for Nanotechnology</u>

Energy: Predicting light absorption, electron transport, and device stability in dye-sensitized solar cells (DSSCs).

Biomedicine: Estimating biocompatibility or antimicrobial activity of nanoparticles before in vitro testing.

Environmental: Modeling pollutant adsorption capacity of various biochar-based nanomaterials.

Applications in Nanomedicine

- **AI-guided Drug Delivery:** Nanoparticle targeting using bio-distribution models
- **Cancer Detection:** DL models analyzing imaging data of nanoparticle-tagged tissues
- **Personalized Medicine:** Matching nanoparticle treatments to patient genomics
- **Smart Sensors:** Wearable nanosensors using AI for real-time health monitoring

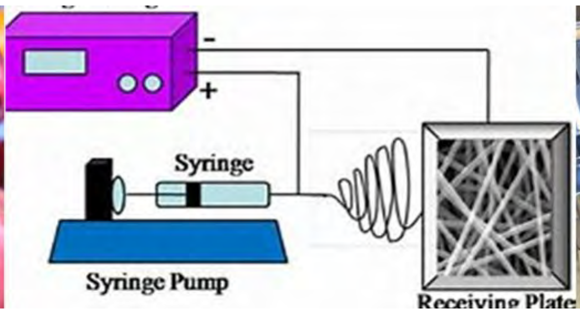
Applications in Materials Science

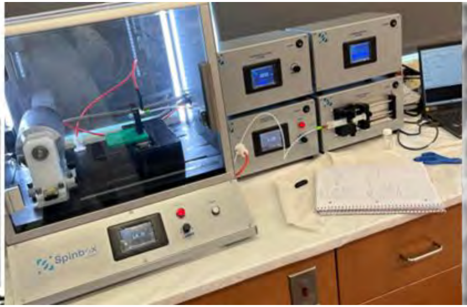
Material Discovery:
Machine learning predicts promising nano-alloys or dopants

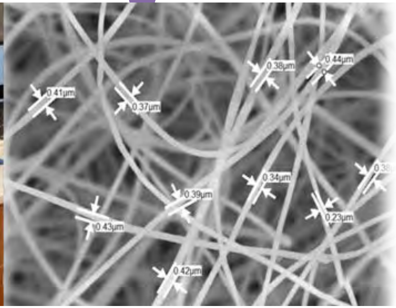
Property Simulation: AI models mechanical, optical, or electronic properties

Advanced Composites: AI-driven optimization of polymer-nanoparticle interfaces.

Example: Ongoing research at Coppin on electrospun nanofibers infused with natural extracts and nanoparticles for antibacterial filters







Case Studies

Integration with Research at Coppin Examples from the Center for Nanotechnology:

AI-assisted design of fluorescent carbon nanoparticles synthesized from teak leaves for DSSCs.

Modeling electrospinning parameters (voltage, viscosity, flow rate) to achieve uniform nanofiber mats for antimicrobial applications.

Optimizing silver nanocube synthesis by correlating morphology with antibacterial performance.

Predictive screening of biochar-based nanocomposites for pollutant adsorption, using machine learning to simulate material efficiency.

Challenges and Limitations

Data Scarcity: Not enough labeled nanotech datasets

Computational Load: High-performance computing is required

Integration Gap: Experimental and AI workflows must sync

Ethical Issues: Transparency, bias, and privacy

Conclusion

AI is transforming nanotechnology at the research and application levels

Work at the Center for Nanotechnology is well-positioned to harness these synergies

Continued development, ethical consideration, and collaboration are key