Meta Materia

Environmental NanoTechnology




MetaMateria Technologies
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Who We Are

- Advanced Materials Company in Columbus Ohio
- Higher Performance Achieved using nano & porous materials

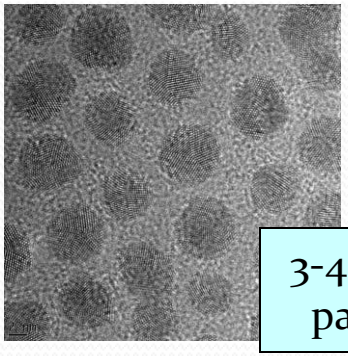
  for Environmental & Energy Applications

- Nano-materials are "*game changing*" technologies
- Products for Water Clean-Up is Primary Focus
- Technologies Used to Remove Nutrients, Metal Ions and other contaminants from water
- Provide Specialty Materials for Energy Systems

Our Core Capabilities

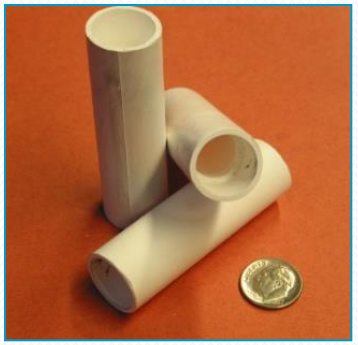
- **Processes for Nano-Enabled Ceramic, metal, and polymers**

- **Engineered Nanoparticles**
  - Colloidal suspensions
  - Nanoparticles under 20 nm



3-4 nm Ag particles

- **Novel, inexpensive ways for making parts**
  - Nano-microstructures
  - Controlled, uniform porosity
  - Complex ceramic shapes



Engineered Nanoparticles

Oxides, Metals , Alloys, Semiconductors, Colloids, Suspensions

Wide Range Nano-materials

Particle Size of Materials Typically <10 nm
Some processes produce 20 -100 nm

Simple Oxides

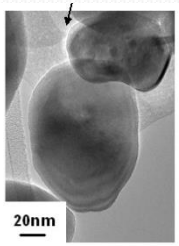
Al_2O_3 • CeO_2 • CuO
Fe_2O_3 In_2O_3 • NiO • SnO_2
TiO_2 • Y_2O_3 • ZrO_2

Complex Materials

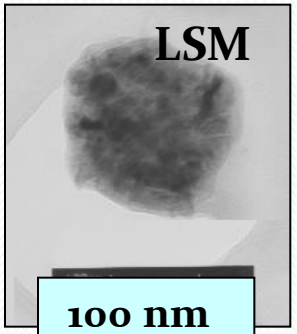
YSZ, SSZ, CGO, LSM, LSC,
LSCF, ITO, PZT, Ferrites, YBCO
Spinels, Semiconductors
(PbTe/PbSe)

Metals

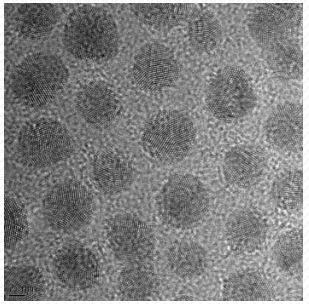
Pt, Cu, Ni, Fe, Zn, Sn,
Ag, Au, Pd, alloys



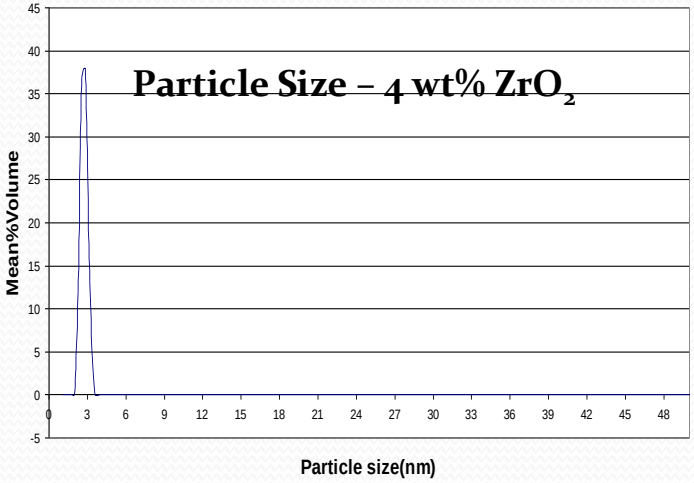
50 nm ZnO Platelets



100 nm particles



4 nm Ag



Applications
for MetaMateria Nanomaterials

- Environmental Cleanup (faster, higher capacity)
- Battery (Thin film & Bulk)
- Solar Cell (Organic photovoltaics)
- Thermoelectrics (built from nanoparticles)
- Membranes (on tailored porous support)
- Polymer Nanocomposites (scratch resistant)
- Nanosolder (lower melting)
- Nanocement (higher strength)

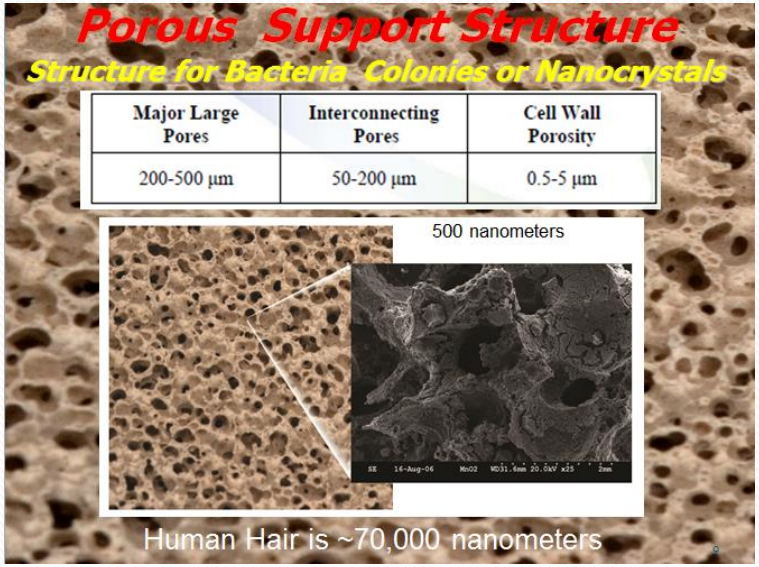
Novel Porous Platform

- ***High surface area***: 100's times higher than other media
  Typically 15 m^2/gram and over 2,000,000 m^2/m^3
- **Alumino-Silicate Bond** >80% interconnected pores
- **Hierarchical Pore Structure**
  Large to nano in size - Allows easy water flow
- **Composition & Shape for System Flexibility**
- **Cost-effective** - allows small footprint

Discs

Plate

Logs



Novel Ceramic Media for Water Purification

BIO Family of Media

- *Increased Bacteria Concentrations*
- *Accelerate Bio-Remediation Cleanup*
- *Control Nitrogen, Organics, Phosphorus*
- *Remove Odors (VOC) from Waste Gas*

Nano-Modified Media

- *Provides Active Sorption Sites, Enhance Kinetics*
- *High Capacity to Removal Phosphorus – PO4 Ions*
- *Remove Meta Ions – As, Pb, Se, Cu, Ni, etc.*
- *Remove Trace compounds (pharmaceuticals, hormones, pathogens, etc.)*

Water Purification Examples of Activities

- Phosphate Removal from Fresh & Waste Water
- Nitrogen & Organic Nutrient Removal
- Waste Gas Cleanup (H_2S, organic odors)
- Remove Metal Ions (Se, As, Pb, Fe, Mn, Cu, etc.)
- Trace Organics in Water
- Perchlorate and Similar Compounds Captured
- Pathogen and Trace Pharmaceuticals Removed

Partnering

- Materials is enabling technology
- Partner with OEM's serving a market
- Work Jointly with Partners
  - Waste Treatment Equipment Manufacturers
  - Engineering Firms (on-site waste treatment)
  - Water Treatment Companies
- Provide packaged media for OEM systems
- Partner for Phosphorous Recovery