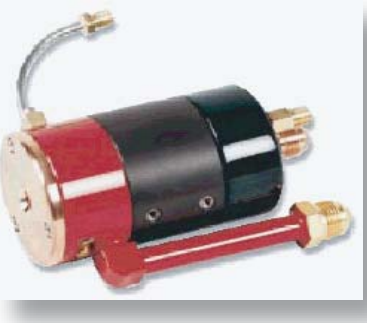
PLASMA FACILITY AT THE NANOMANUFACTURING LAB

PLASMA SPRAY FACILITY

•Net Energy™ process control for repeatable and consistent coating quality
•User Friendly teach pendant for robot programming
•Integrated infrastructure
•Periodic dimensional check in between the spray cycles

PLASMA SPRAY GUN



•3 modes of operation for tailored coatings
•Internal or external powder injection (or both)
•Self-aligning components
•Long-life anodes and cathodes
•High spray rates
•CE Compliant
•Up to 80 kW

POWDER FEEDER

•Digital display and toggle-switch controls
•Variable powder wheel speed
•High-capacity powder canister; optional double-stack canister
•Plasma/HVOF operation selector
•Heater blanket with on/off control
•Multiple powder wheel options available

6 AXIS PROGRAMMABLE ROBOT

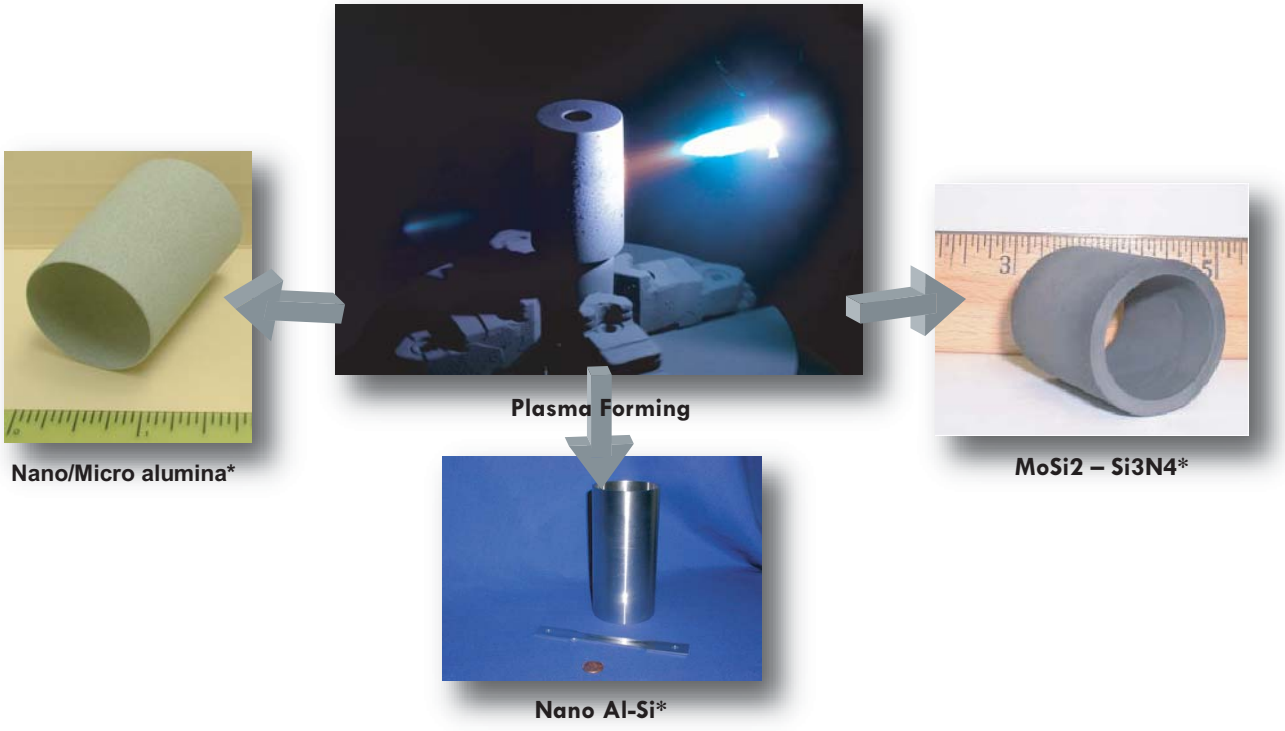
•1.5 m Reach from the grounded position
•Program Memory : 3000- 12000 Instructions (1-5 MB)
•Storage Memory : 3000 – 35000 Instructions (0.5–5 MB)
•Robot arm Velocity : 0.5 mm/Sec to 200mm/Sec
•6 axis movement with convenient orientation
•Helps make a reproducible coating every time with a given program

PLASMA FACILITY AT THE NANOMANUFACTURING LAB

In our consistent effort to achieve a bulk component with retained nano structures, the concept of application of fourth state of matter to the development of Nanostructured bulk component has been thought of and the result was an unique, state of the art Plasma Nano manufacturing facility at the UCF Technology Incubator being funded by the Office of Naval Research, DURIP. This facility is being used to convert the scientific know-how to the much needed technological know-how.

Plasma Spray Facility:

This facility has all the complete infrastructure required for bulk nano processing, under one roof starting from a Grit blaster for surface preparation, a spray drier for agglomeration, to plasma spray equipment in a controlled booth. With enough trained personnel to process the component and characterization techniques to characterize it, The Plasma Nanomanufacturing Facility is clearly the leader in providing the cutting edge technology. Nano grain structure of the powders before spraying has been retained even after spraying to form a bulk nano part.



Multi-faceted applications of Plasma spray technology
*** Courtesy – Plasma Process Inc. HuntsVille Alabama**

SPRAY DRYING

Spray drying is a very widely applied, technical method used to dry aqeous solutions, emulsions etc. in the industrial chemistry and food industry. Dry milk powder, detergents and dyes are just a few spray-dried products currently available. Spray drying can be used to preserve food or simply as a quick drying method. It also provides the advantage of weight and volume reduction.

Intruction of Equipment
The Büchi Spray Dryer B-290 represents a new dimension in research and development. In just minutes, this instrument produces uniform powders from 50 ml or less of organic or aqueous solutions, saving you time and costly samples. Preparation and cleaning times are reduced to an absolute minimum, which results in increased productivity and efficiency in the development process. In addition, the new B-290 comes equipped with several safety measures that ensure successful spray drying and trouble-free processing.

Applications

- Spray drying from organic or aqueous solutions
- Structure modifications
- Drying of suspensions
- Agglomeration
- Spray crystallization
- Microencapsulation and coating

Practical Examples

- Foodstuffs: baby food, dried milk, grain products
- Medical, Pharmaceutical: blood plasma, vaccinations, albumin, various plant extracts
- General industry: detergents, latex, dyes, aromatic substances, perfumes
- Chemical industry: calcium carbonate, aluminum oxide, titanium oxide, zeolite, etc.
- Ceramic Industry: various ceramic substances

Figure 1. Buchi B-290 Spray Dryer

Agglomeration of nanopowders
For plasma forming of materials, the characteristics of the powder play a critical role in the mechanical properties of the resultant material. Research in this field reports that a spherical morphology of the powder is necessary to increase efficiency of this synthesis method.

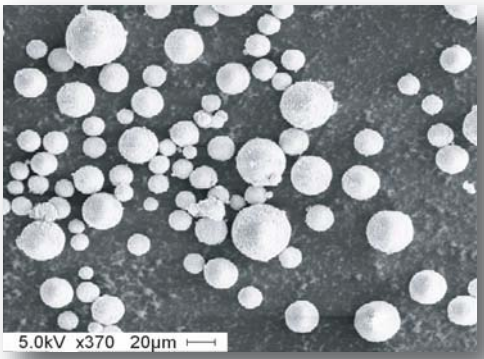


Figure 2. SEM image of Aluminum Oxide powder after spray drying agglomeration
Particle shape is highly spherical and diameter is 10-25 µm.

SPRAYWATCH-2I OSEIR LTD.

System Description

The SprayWatch system assists in the quality assertion and diagnostics requirements of thermal spray process. The major benefits of such system are associated with improved coating quality, better reproducibility of coatings and faster process development. The Spray Watch system is designed with the purpose of radical savings in time, work, test pieces and produced crumb.

Fig.1. The light weight camera

Features

- Images the particle flow and measures the most significant characteristics of the particles just before they form the coating on the target surface
- Based on modern CCD camera and image processing technology
- Features in process measurement of most important spray and particle parameters

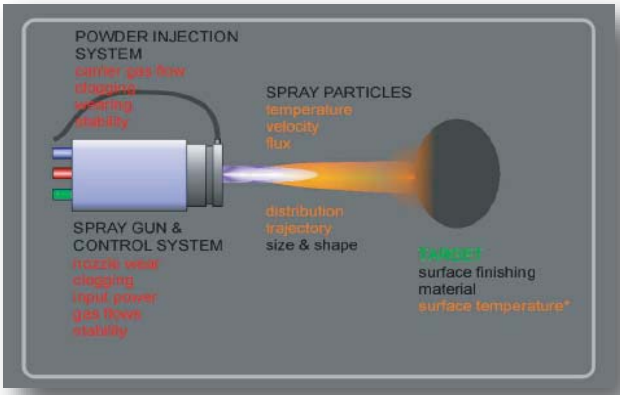


Fig. 2. Trouble shooting of the spray process

Advantages

- Know ***what*** really happens in the plasma process
- Recognize ***why*** something happens
- Develop understanding ***how*** to achieve the best quality for your coating
- Collect and analyze ***data*** for quality files
- Save ***information*** for tracing needs
- Proper process ***characterization*** with real and actual process parameters
- Establish process ***limits***
- Real time, in-process continuous process ***monitoring***
- Data logging for further ***improvement***

Fig. 3. The feedback to the operator: particle temperature, velocity and flux

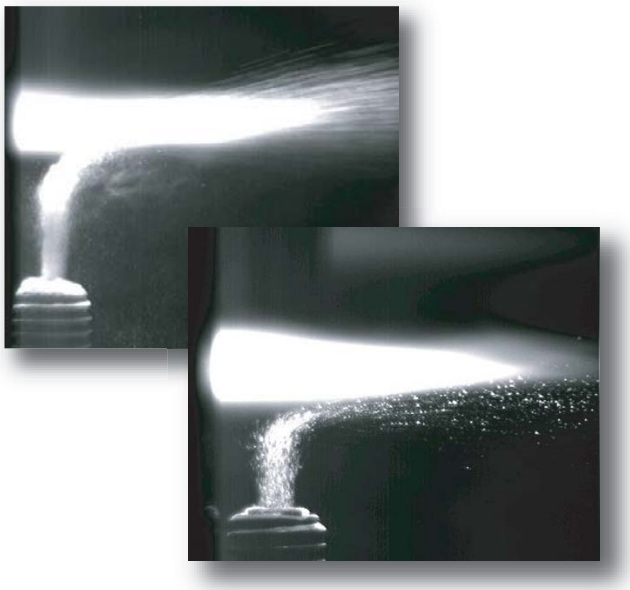
Specifications

- Particle and substrate temperature
- Velocity
- Flux and distribution
- Spray width
- Angle
- Position
- Intensity

HIWATCH OSEIR LTD.

System Description

The HiWatch system is an all-solid-state laser system for justification of flow and spray processes. In addition to the visualization of the process, the system assists in the measurements of the several flow and spray parameters such as velocity, size and shape of particles, droplets or bubbles, spray patterns, etc.

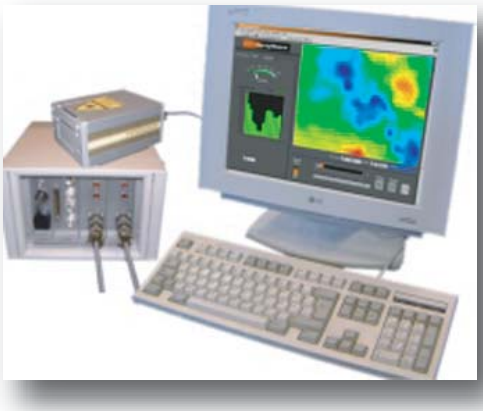


Advantages Over Dual-Pulse Yag Lasers

- Correlation analysis of flow images is more reliable with multi-pulse illumination, even with weak signal levels
- Some analysis techniques, such as acceleration field measurement, are feasible only with multi-pulse exposure

Features

- Visualize the spray or mixed-flow patterns
- Visualize the flow or spray interaction with a solid target
- Measure the spray or flow distances, velocities, particle or solid matter density fields
- Image and size particles
- Detect fast, small solid objects at a large distance
- Visualize particles or solid objects in high- or variable-intensity environments like flames, sparks or explosions
- Optical components stand humidity, dust and corrosive effects



MATERIALS STUDIO PACKAGE: ACCELRYS

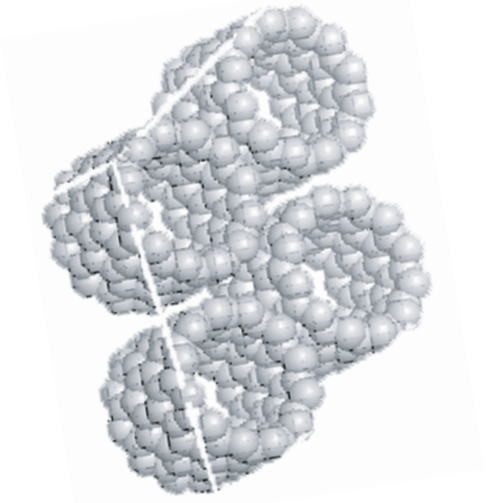
A new tool for crystal structure modeling and property evaluation.

- Increase the understanding of materials and improve the communication of chemical information
- Visualize and model structures from chemical databases
- Build molecules and materials
- Calculate and display key structural parameters
- Display the results of calculations – animated dynamics trajectories, graph data, and molecular models
- Applicable to Materials Manufacturing, Nanostructures, Catalysis, Biomolecules, Surface Engineering and Surface/Interfaces

- **CASTEP** - a powerful *ab initio* Quantum Mechanical program
- Utilize density functional theory (DFT)
- Toward simulation of the properties of solids, interfaces and surfaces
- Applicable for a wide ranges of materials including ceramics, semiconductors and metals

The intention of the simulation study:

- Integrating the essential electron - electron level principles with the important mechanisms at the microstructural level
- Combining the multiscale simulations with the optimized experimental parameters as a potent tool for developing a nanocomposite system with enhanced properties for various important engineering applications



Carbon Nanotubes Modeling

Motivation

Nanomanufacturing demonstrates evident promise for the synthesis and the consolidation of metal/ceramic nanocrystalline powders into free-form bulk nanocomposite components.

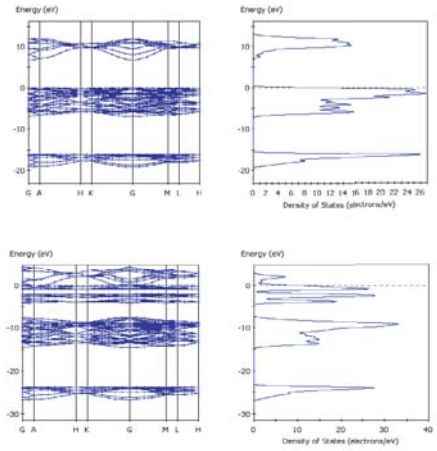
Example: Ni/Alumina Bulk Nanocomposite

- Al2O3 has high strength, good corrosion resistance, low thermal and electrical conductivity, and low density
- Ni offers several advantages such as high melting point, high thermal expansion coefficient, and relatively low cost
- Alumina nanocomposite with nickel addition exhibits improved fracture toughness and superior ferromagnetic properties
- The simulated results can be effectively applied toward the development of metal/ceramic nanocomposites with enhanced mechanical properties

Methodology

The orbital occupation, the changes in the density of states, the band structures, the shift in the Fermi energy and the optimization of the total energy of the Ni/alumina system were investigated and correlated to the increased strength of the composite system and the interface bonding.

- A Ni atom contains 8 electrons on the d-orbital and 2 on the 4s orbital
- The large band gap in Alumina evidently corresponds to its poor conductivity properties
- If Ni is added to a system such as alumina, it is expected that it would play a major role for the decreasing the band gap, lowering of both the Fermi energy and the total energy of the system
- Similar calculation can be applied to other metal, metal/ceramic and ceramic/ceramic systems



The band structure and density of states of Alumina and Ni/Alumina