National Laboratory in Nanotechnology in Chihuahua and the Nanotechnology Incubator in Monterrey

Dr. Jesús González Hernández

Centro de Investigación en Materiales Avanzados, A.C.

3rd TRI-NATIONAL WORKSHOP ON STANDARDS FOR NANOTECHNOLOGIES

Centro Nacional de Metrología

Querétaro, Qro., Feb., 12, 2009

Outline

- *General Information about CIMAV (Research Center in Advanced Materials)*
- *Nanotechnology at CIMAV (Chihuahua & Monterrey)*
- *National Laboratory in Nanotechnology at CIMAV (**NaNoTeCh**)*
- *Diagnostic & Prospective of the Nanotechnology in México*
- *Nanotechnology Incubator at the Research & Innovation Technology Park at Monterrey*

CONACYT Public Research Centers System

Monterrey

CONACYT
Consejo Nacional de Ciencia y Tecnología

- Total
  - 27 CONACYT Public Research Centers
- Located in
  - 24 States
  - 42 Cities

- 10 Exact & Natural Sciences
- 8 Social & Humanity Sciences
- 9 Engineering & Technology

Main Facilities **Branches**

CIMAV Personnel

179 Employees

135 Scientific & Technological

- ✓ 40 Full Researchers
- ✓ 4 Associated Researchers
- ✓ 67 Full Technicians
- ✓ 10 Associated Technicians

56 PhD, and 20 M. D.

8 Support to Research Activities

41 Administrative

Academic Structure

Departments:

- Physics of Materials
- Chemistry of Materials
- Environment and Energy

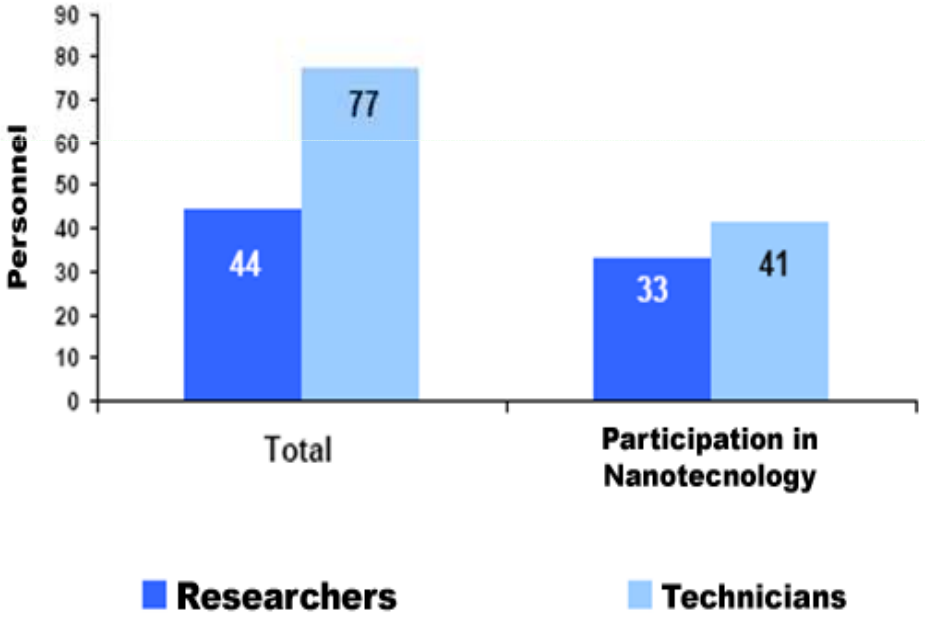
Institutional Programs:

- Nanotechnology & Nanoscience
- Alternative Energies

Nanotechnology activities at CIMAV

(2007-2008)

Researchers and Technicians Working in Nanotechnology at CIMAV

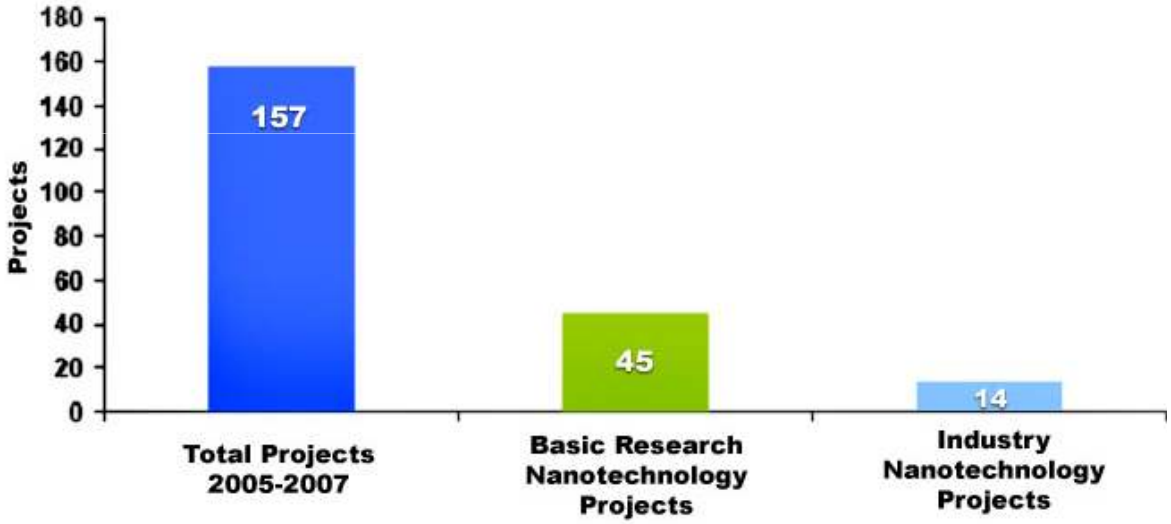


Scientific Articles in Nanotechnology

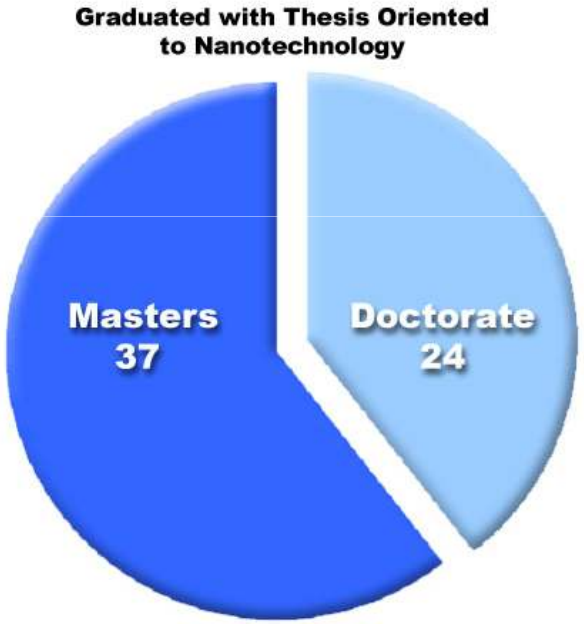
23 Patentes in 2007-2008, 9 in Nanotechnology

Projects and Students in Nanotechnology in CIMAV

Nanotechnology Projects: Basic Research and Industrial



Graduated Students
(Total more than 250)



National Laboratories

(Federal, Chihuahua State and CIMAV funding)

Results Published by CONACYT, Dec. 2006

Laboratorio Nacional de Nanotecnología en el CIMAV	*CIMAV IPICyT*
Centro Nacional de Investigación en Imagenología e Instrumentación Biomédica	*UAM*
Laboratorio Nacional para la Evaluación de los Recursos Energéticos Renovables en México	*IIE*
Delta Metropolitana de Cómputo de Alto Rendimiento	*UAM*
Laboratorio de Microarreglos para Genómica Funcional e Identificación de Organismos	*CIAD*

Objectives

Support Mexican Organizations to:

① *Development of human resources*

② *Generate scientific knowledge*

③ *Establishing collaboration mechanisms*

④ *Establishing strategic alliances with high-tech Mexican companies*

Experimental Infrastructure

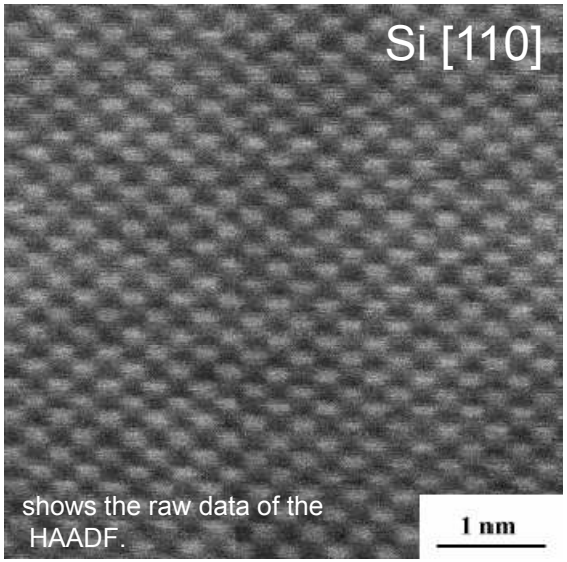
JEOL-2200FS HR-FE-TEM

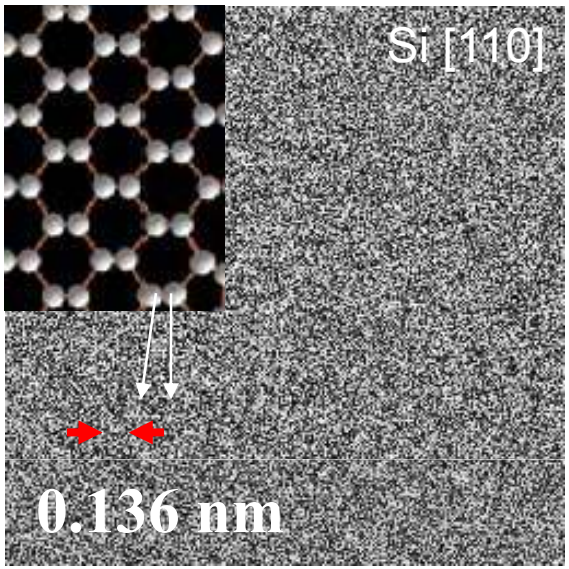
- *STEM Resolution: 0.07nm*
- *Magnification: up to 1,500,000*
- *STEM Cs corrector*
- *GAT-777 Gatan STEMPACK*

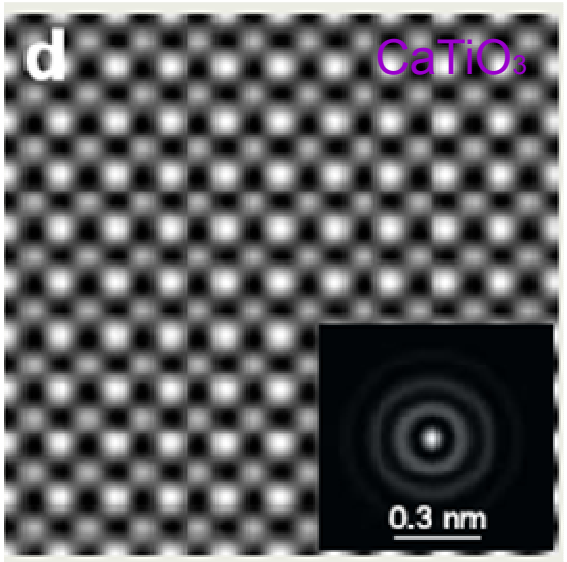
PHILIPS CM-200 TEM

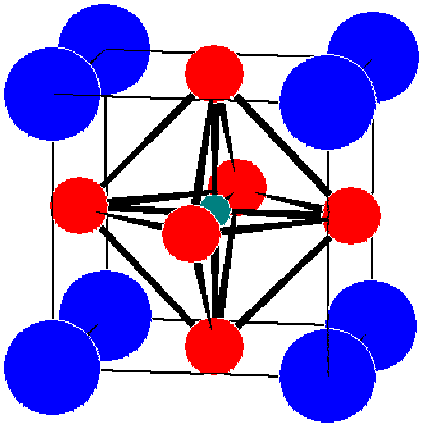
- *Resolution: 0.20 nm*
- *Magnification: 750,000*
- *TEM/STEM modes*

Images obtained with the Jeol 2200 TEM









Ca^{+4}

O^{-2}

Ti^{+4}

NaNoTeCh
Laboratorio Nacional de Nanotecnologia

JEOL-7401F FE-SEM

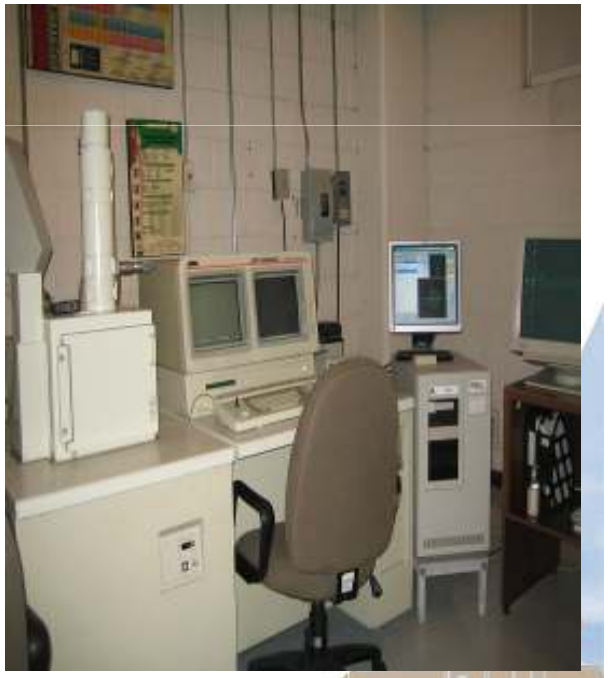
- Resolution: 1.0nm
- Magnification up to 1,000,000X

Nova 200 NanoSEM HR-FE-SEM

- Resolution: 0.8 nm, 1,000,000 X
- STEM detector
- Low-High vacuum

JSM 5800-LV SEM

- Tungsten Emission Filament
- Maximum Resolution: 3.0 nm
- Magnification: 500,000x



Sample Preparation

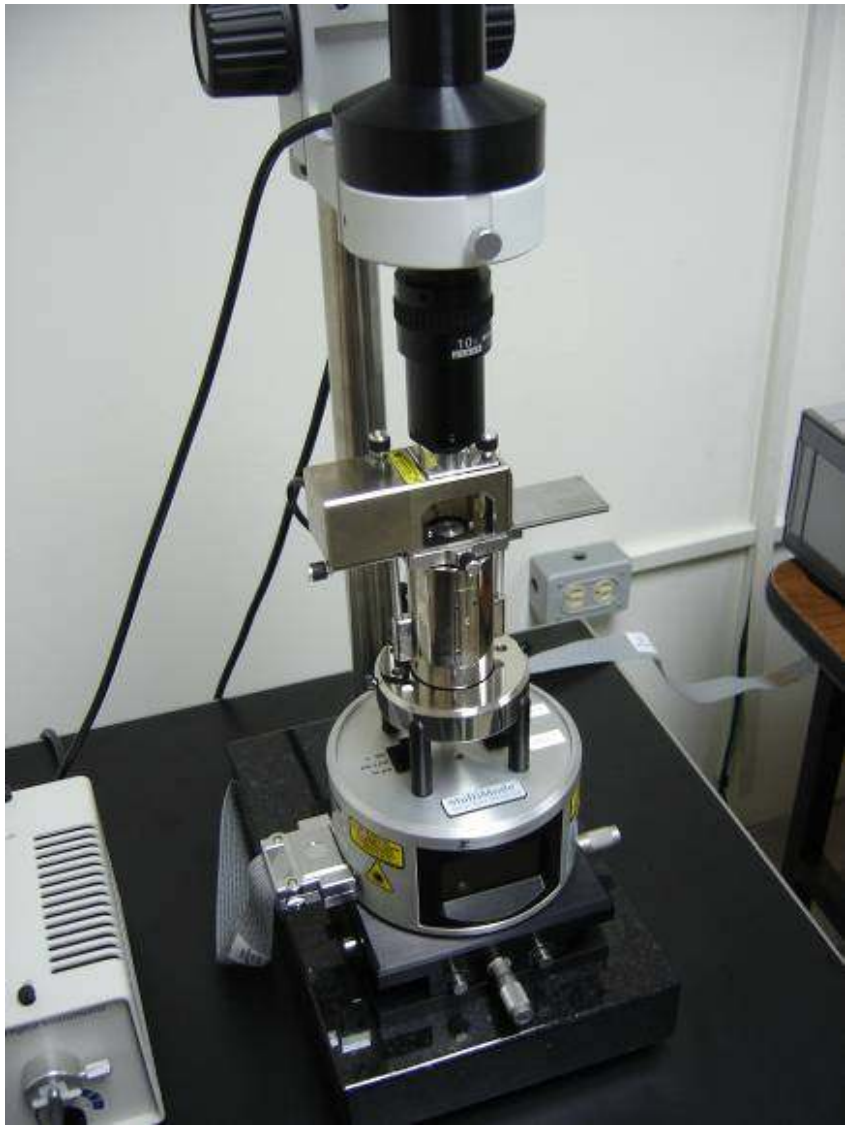
JEOL-9320FIB

- Maximum Resolution: 5.0 nm
- Magnification: 400,000x
- Ion gun: Ga ion source
- Metal Deposition Unit
- Nanomanipulator

Plasma Etching

- Ar plasma etching
- Ion Voltage 2-6 kV
- Etching speed 1.3 µm/min (6kV in Si)

NaNoTeCh
Laboratorio Nacional de Nanotecnologia



SCANNING PROBE MICROSCOPE

- *AFM Contact Mode*
- *Tapping Mode*
- *Lateral Force Microscopy (LFM)*
- *Magnetic Force Microscopy (MFM)*
- *Scanning Tunneling Microscopy (STM)*
- *Electric Force Microscopy (EFM)*
- *Scanning Capacitance Microscopy (SCM)*
- *Surface Potential Microscopy*
- *Electrochemical Microscopy*
- *Nanoindntation/Scratching*

Nanotechnology in México

SE
SECRETARÍA DE ECONOMÍA

Objective:

Identify potential areas of opportunity for Mexico in this megatrend as well as the actions which could be useful in the design and implementation of adequate public policies, for the development of nanotechnology in Mexico

Participants:

56 Academic Institutions
101 Companies

Results:

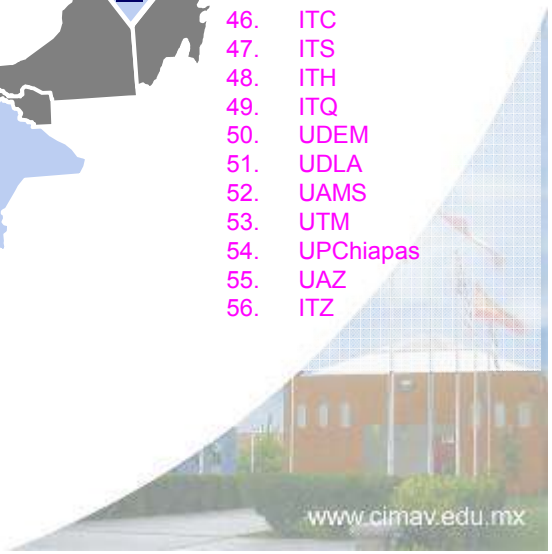
- *Inventory of capacities*
- *Key competences*
- *Opportunities and niches*
- *Public policies*
- *Conclusions*

Inventory of Academic Capabilities

Nanotechnology in Mexico

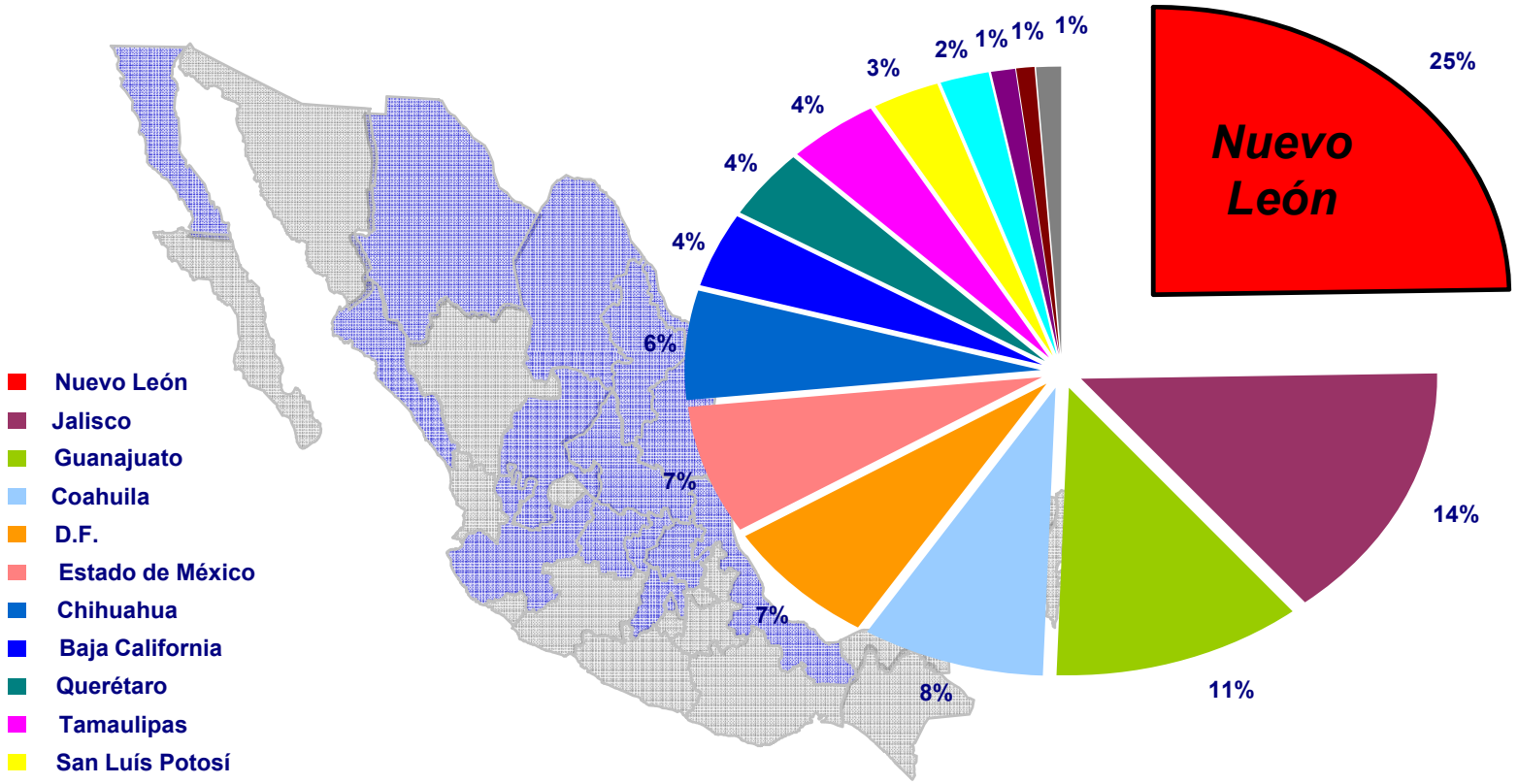
6-IPN	8 - UNAM	3- Research Institutions "Sectorizadas"	14- CPI, CONACYT System	25- IES	56 Institutions

1. CINVESTAV México
2. CINVESTAV Mérida
3. CINVESTAV Querétaro
4. CINVESTAV Saltillo
5. CIITEC -IPN
6. ESFM -IPN
7. IF- UNAM
8. IQ- UNAM
9. CIE- UNAM
10. IIM-UNAM
11. CFATA-UNAM
12. CCADET- UNAM
13. FC- UNAM
14. CCMC- UNAM
15. IMP
16. ININ
17. CENAM
18. CIMAV
19. CIQA
20. CIDESI
21. CIATEC
22. CICY
23. CICESE
24. CIAD
25. CIATEJ
26. CIBNOR
27. CIDETEQ
28. CIO
29. CIATEQ, A.C.
30. COMIMSA
31. IPICYT
32. BUAP
33. UACH
34. UACJ
35. UANL
36. UASLP
37. UADY
38. UAEH
39. UAM-Azcapotzalco
40. UAM-Iztapalapa
41. UDG
42. UG
43. UNISON
44. UMSNH
45. UV/MICRONA
46. ITC
47. ITS
48. ITH
49. ITQ
50. UDEM
51. UDLA
52. UAMS
53. UTM
54. UPChiapas
55. UAZ
56. ITZ



Inventory of Industrial Capabilities

Geographical Location of Surveyed Companies



SE
SECRETARÍA DE ECONOMÍA

CONACYT

FUNTEC

inncom
innovación y competitividad sa de cv

cimav

www.cimav.edu.mx

Opportunities in Nanotechnology in Industry of Nuevo León

Academic & Industrial Capacities

- ***8 National Academic Institutions (14%)***
- ***3 Foreign Universities***
- ***26 Companies (25%)***
- ***27 Nanotech industrial projects***

1. The industries with higher interest:

- *Plastics and polymers*
- *Coatings and paints*
- *Glass, Cement, ceramics, textiles*
- *Metal industry (wire, cables and alloys, Cu and Al)*
- *Chemical industry (catalyst, organic synthesis, oil industry)*
- *Electronic industry*

2. What they need, what kind of prime materials?

- *Nanoparticles, {metal oxides, metal chlorides, metal hydroxides, metals (Ag, Au, Pt, Pd, Al, Cu) and nanoclays}*
- *Inorganic nanostructured materials (metal oxides, ceramic compounds)*
- *Polymer composites (nanoclays, nanoparticles specially in PP,PE, Nylon)*
- *Carbon nanotubes*

Strategy for the Development of Nanotechnology in the State of Nuevo Leon

PIIT- Research and Innovation Technology Park

Cluster of Nanotechnology

32 | negocios | MILENIO

Integran cluster de nanotecnología

Creación de estos materiales beneficiará a empresas como Cemex, Cydsa y otras

Incubator for Nanotechnology

6 Technological Platforms
(Pilot Plants)

2 Nanoparticles

1 Carbon Nanotubes

1 AACVD Thin Films

1 Application to Final Product

Companies Integrating the Cluster of Nanotechnology of Nuevo León

Cluster of Nanotecnología

16 empresas

Empresas que integran el Cluster
Cemex Central, S.A. DE C.V.
Cydsa, Corporativo
Lamosa, S.A. de C.V.
MABE, S.A. DE C.V.
METALSA, S. de R.L.
Owens Corning, S de R.L. de C.V.
Palmex Alimentos S.A. de C.V.
Prolec G.E.
SEDEC
Sigma Alimentos
Simplex, S.A. de C.V.
Ternium
Univex, S.A.
Viakable
Vitro Corporativo, S.A. de C.V.
Whirlpool

Academic Institutions Integrating the Cluster of Nanotechnology of Nuevo León

Nationals

- ***CIDESI:*** *Centro de Ingeniería y Desarrollo Industrial (Design and fabrication of equipment, PP)*
- ***UANL:*** *Universidad Autónoma de Nuevo León (Nanoparticles and nanomaterials)*
- ***CIMAV:*** *Centro de Investigación en Materiales Avanzados (Nanoparticles and nanomaterials)*
- ***ITESM:*** *Instituto Tecnológico y de Estudios Superiores de Monterrey (Nanomaterials)*
- ***IIE:*** *Instituto de Investigaciones Eléctricas (Nanomaterials and energy applications)*
- ***CIQA:*** *Centro de Investigación en Química Aplicada (Nanocomposites with polymeric matrix)*
- ***CIAD:*** *Centro de Investigacion en Alimentos y Desarrollo (Nanobiotechnology)*
- ***CINVESTAV:*** *Centro de Investigación y de Estudios Avazados del IPN (Nanobiotechnology)*

Foreign

- ***Arizona State University :*** *Nanotechnology Cluster of North America*
- ***University of Texas:*** *IC²: Business plans and Tech Transfer, MCS&T*
- ***Texas A&M:*** *Manufacturing*

Incubator for Nanotechnology

Platforms

Incubator will install equipment with the follow technological platforms

1. *Nanoparticles (top-down, bottom-up)*
    1. *Wet Chemistry*
    2. *Physical-Chemical Methods**
2. *Nanofilms*
    1. *Aerosol Assisted Chemical Vapor Deposition*
3. *Nanocomposites with Polymeric Matrix (PP, PE, Nylon, PVC.)**
4. *Carbon Nanotubes*
5. *Nanobiotechnology (Supercritic Fluids)*

** Foreign Technologies*

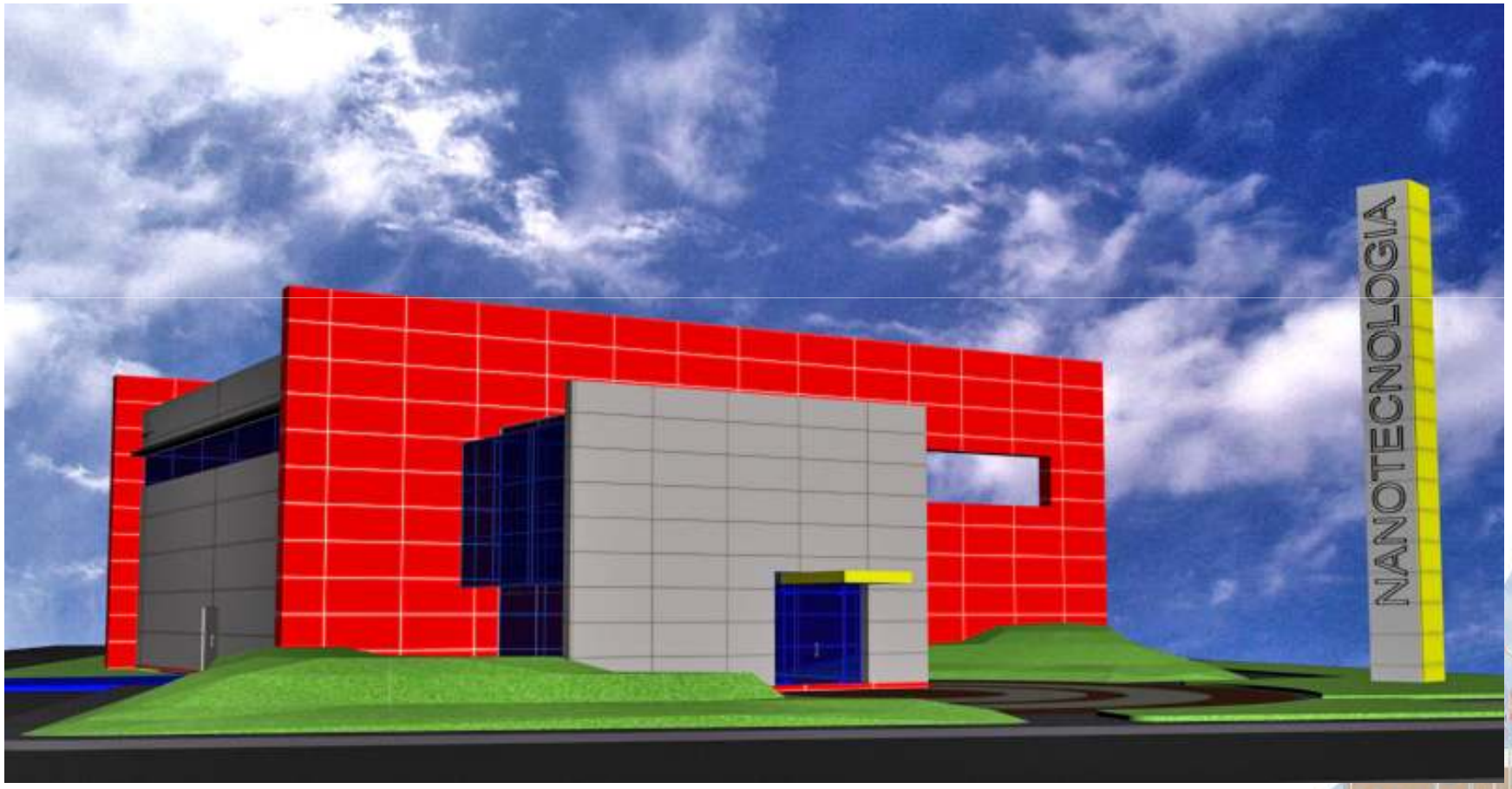
Incubator for Nanotechnology

Pilot Plants

The pilot plants were selected according to the follow considerations:

1. *Patented, patent filed or in process.*
2. *Minimum production capacity kg/h*
3. *Pilot plants must produced a wide range of products and be flexible for experimentation.*
4. *The institution or company must accept one initial payment for the use of the technology, and when some company develop a new product or process with their technology will pay a licensee fee to the technology owner.*

Incubator for Nanotechnology



Incubator for Nanotechnology Location

Research and Innovation Technology Park

Monterrey, N.L.

XETACOMP Physical-Chemical Method

Company Profile

Xetacomp is located at Oklahoma City

The company provides nanomaterials of extremely high surface-area at low cost.

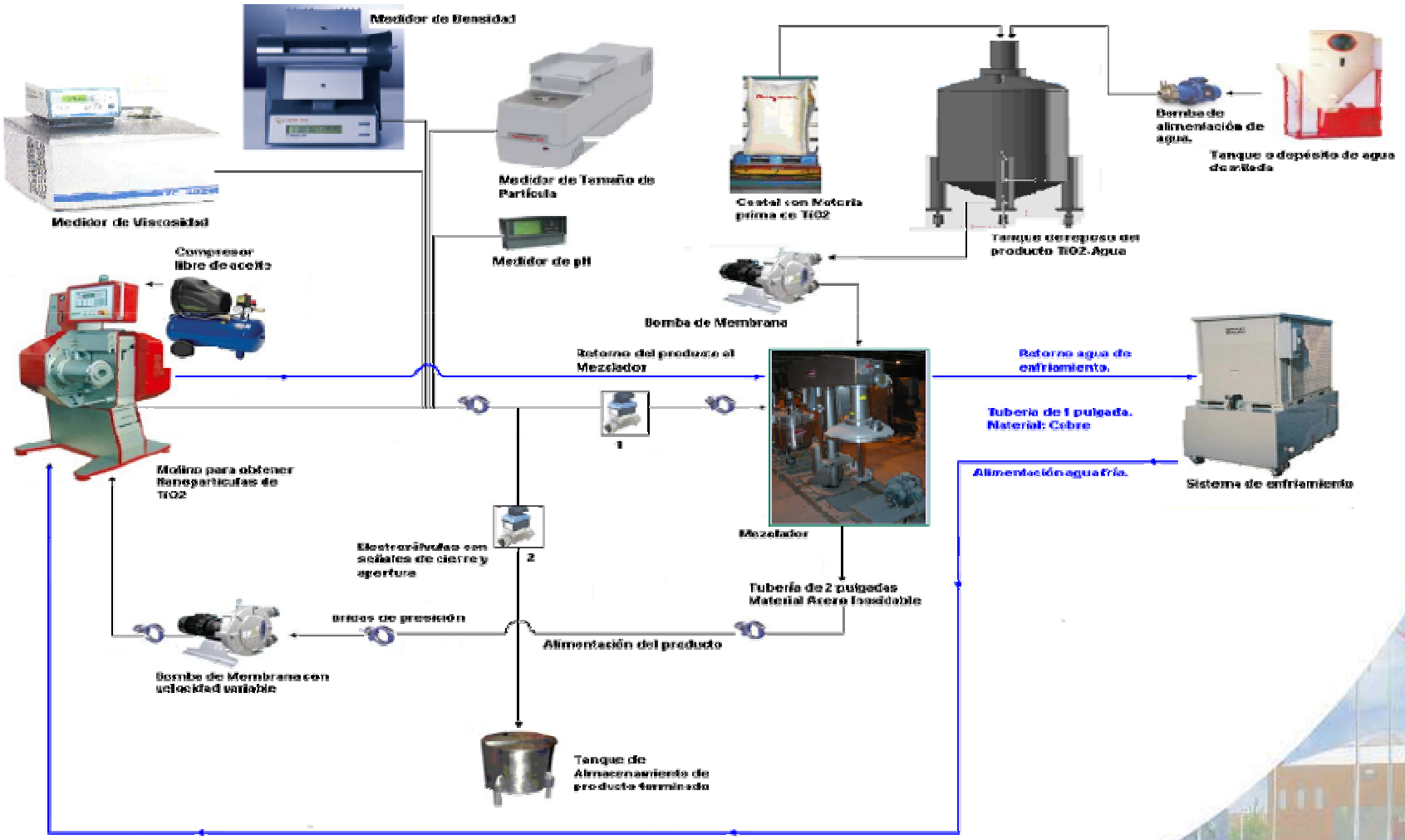
The process can produce a variety of nanoparticles like Titanium Dioxide, Coated Titanium Dioxide, Zinc Oxide, Silicon Dioxide, Nanoclays, Metals and others.

The particle size ranges from 10 to 80 nm in suspension and functionalized for applications in coating, paints, plastics, cosmetics, sunscreens.

Xetacomp developed and sales sunscreens, lotions and creams with the tradename Sunvex based on TiO2 and ZnO

Technology platform: Physical-Chemical Method

XETACOMP



Nanocomposites with Polymeric Matrix

Center for Applied of Nanotechnology (CAN) Hamburg, Germany

Company Profile

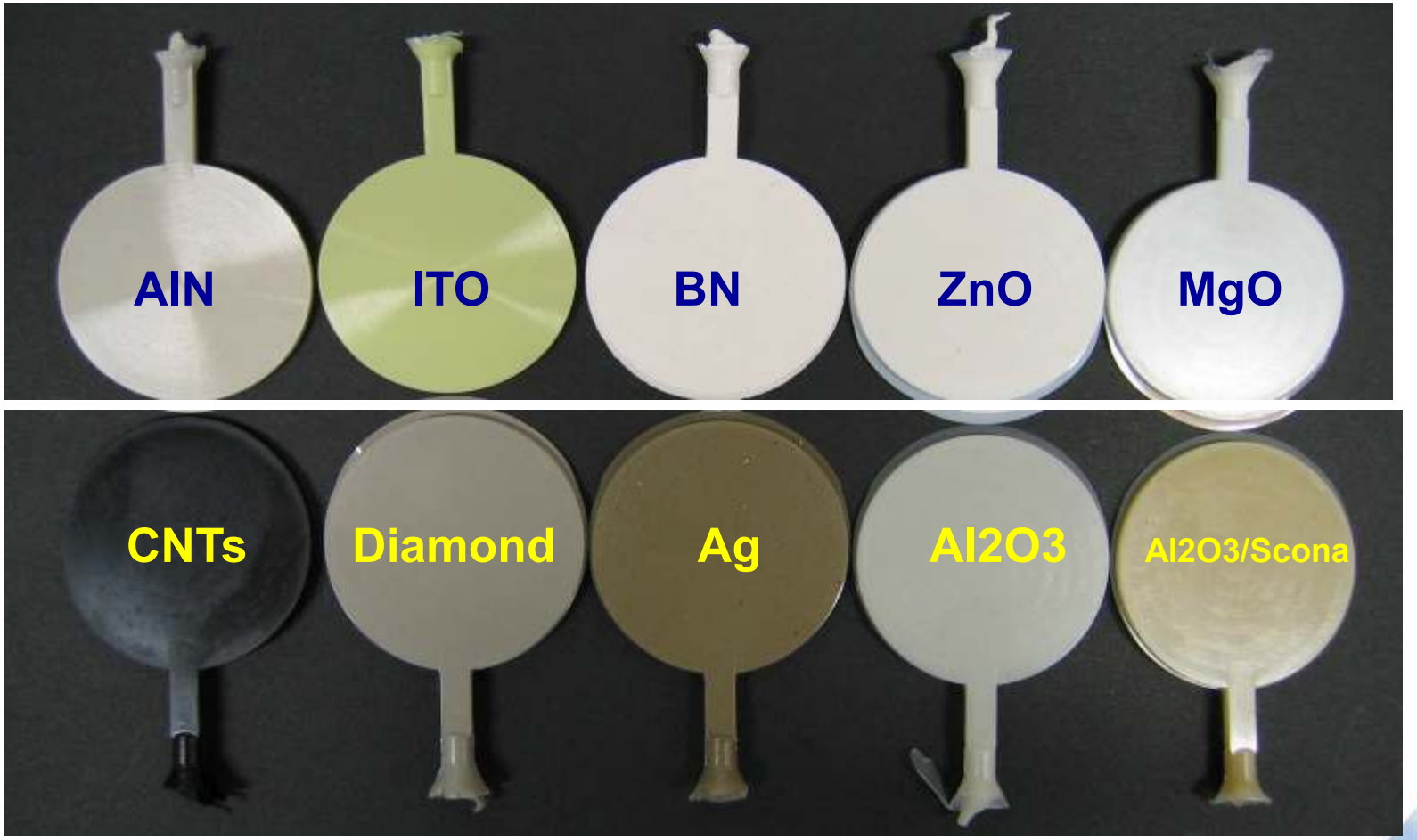
CAN is located at Hamburg Germany and offers companies and research institutions contract research and development services in the area of nanotechnology

The main areas of expertise are the production of:

- *nanoparticles and **nanocomposite** materials,*
- *encapsulation of biological active ingredients*
- *development of nanoparticle for biological and medical markers*

CAN works in association with the Technical University of Hamburg .

Polymers with Nanoparticles CAN



Example: PP based nanocomposits (different nanoparticles)
Sample diameter 35 mm, sample thickness 0,5 mm

Modified Sol-Gel Method

Patent filed by the Autonomous University of San Luis Potosi

About the Method and Product

- Modified Sol–Gel Method
  - Bottom-up: nucleation and growth of particles in wet environments

- Method features
  - Simple
  - Friendly with the environment
  - Scalable
  - Low cost

- Nanoparticle features
  - Sizes < 100 nm (size and shape tunable)
  - Narrow size distribution
  - Good dispersion
  - 1 Kg/hr of nAg or 10 Kg/hr of $nMg(OH)_2$

Modified Sol-Gel Method
lay out scheme

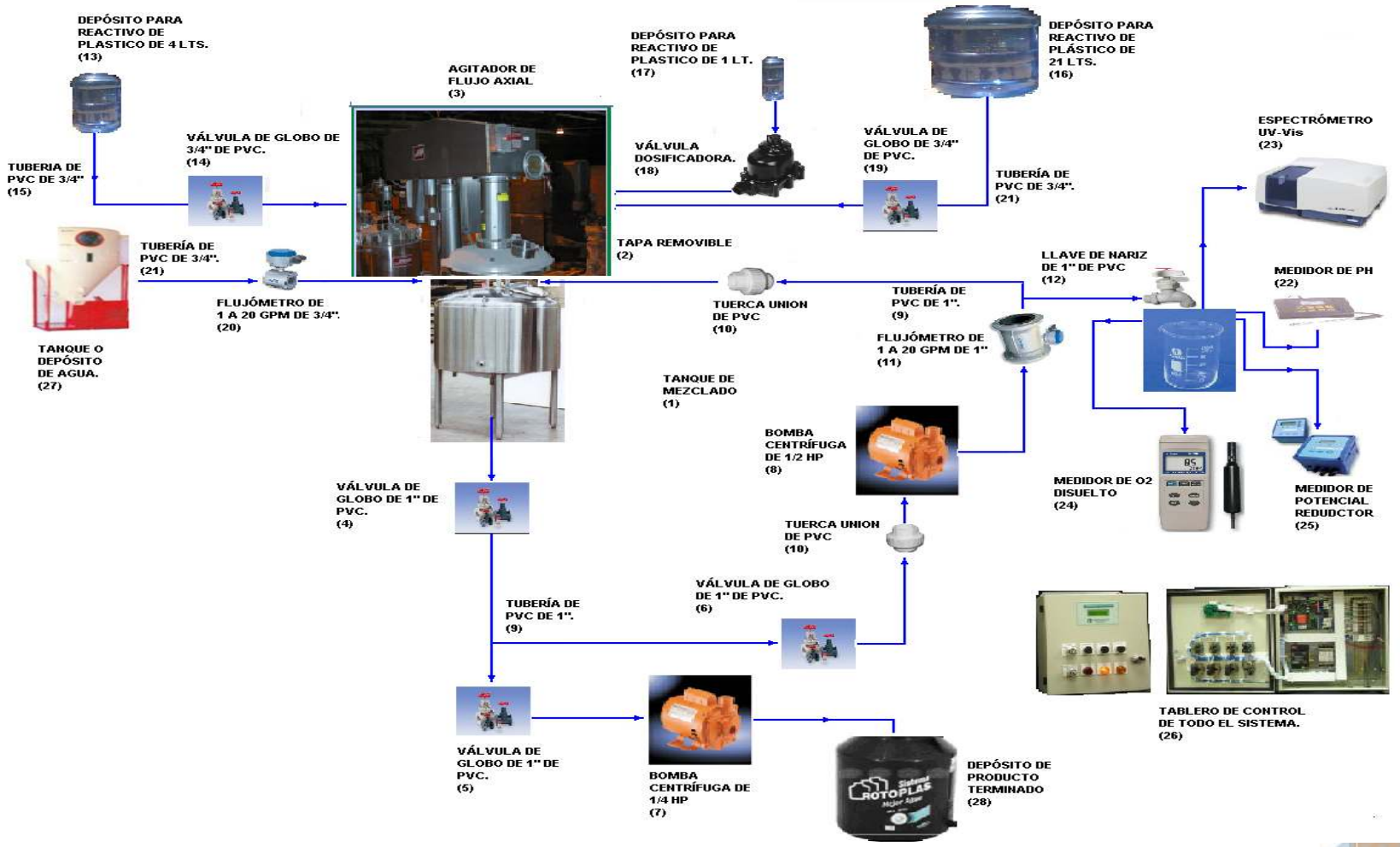


Figura 1. Esquema del Sistema de Producción de Nano-partículas de Materiales Compuestos.

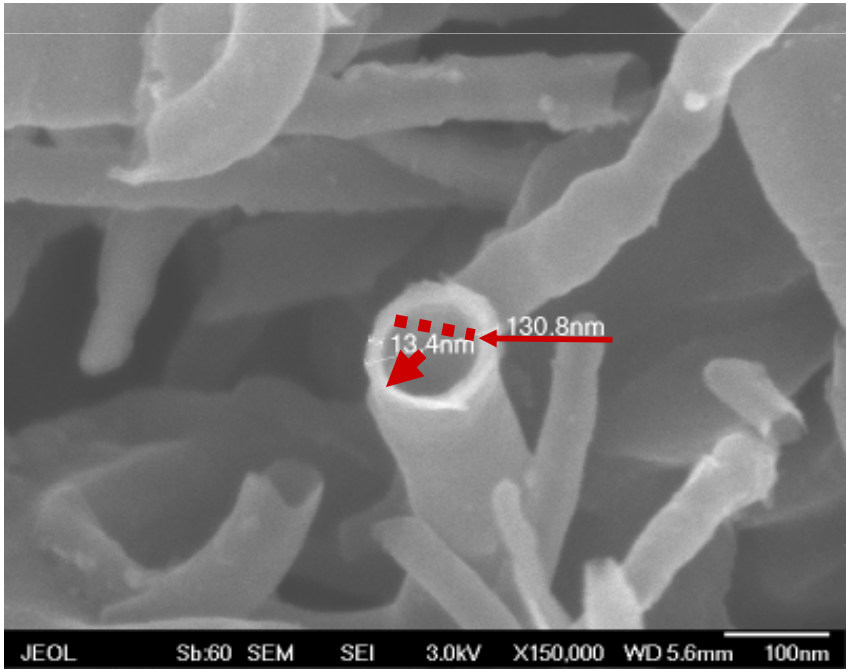
MWCNT Pilot Plant: First prototype (CIMAV)

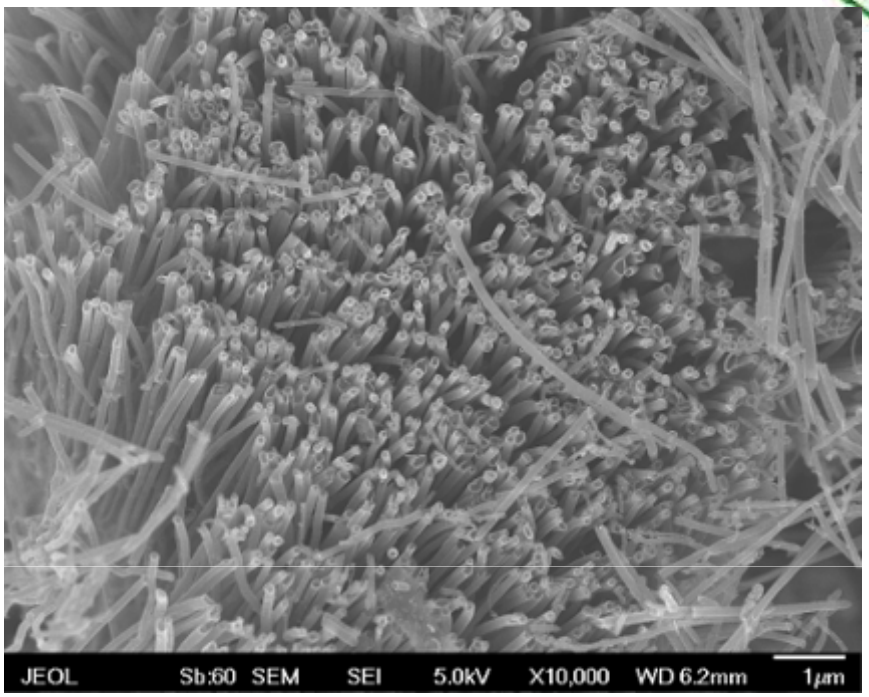
Production capacity: 25 gr/hr

Patent filed by CIMAV

Síntesis of wide CNT with a thin wall

Patent pending



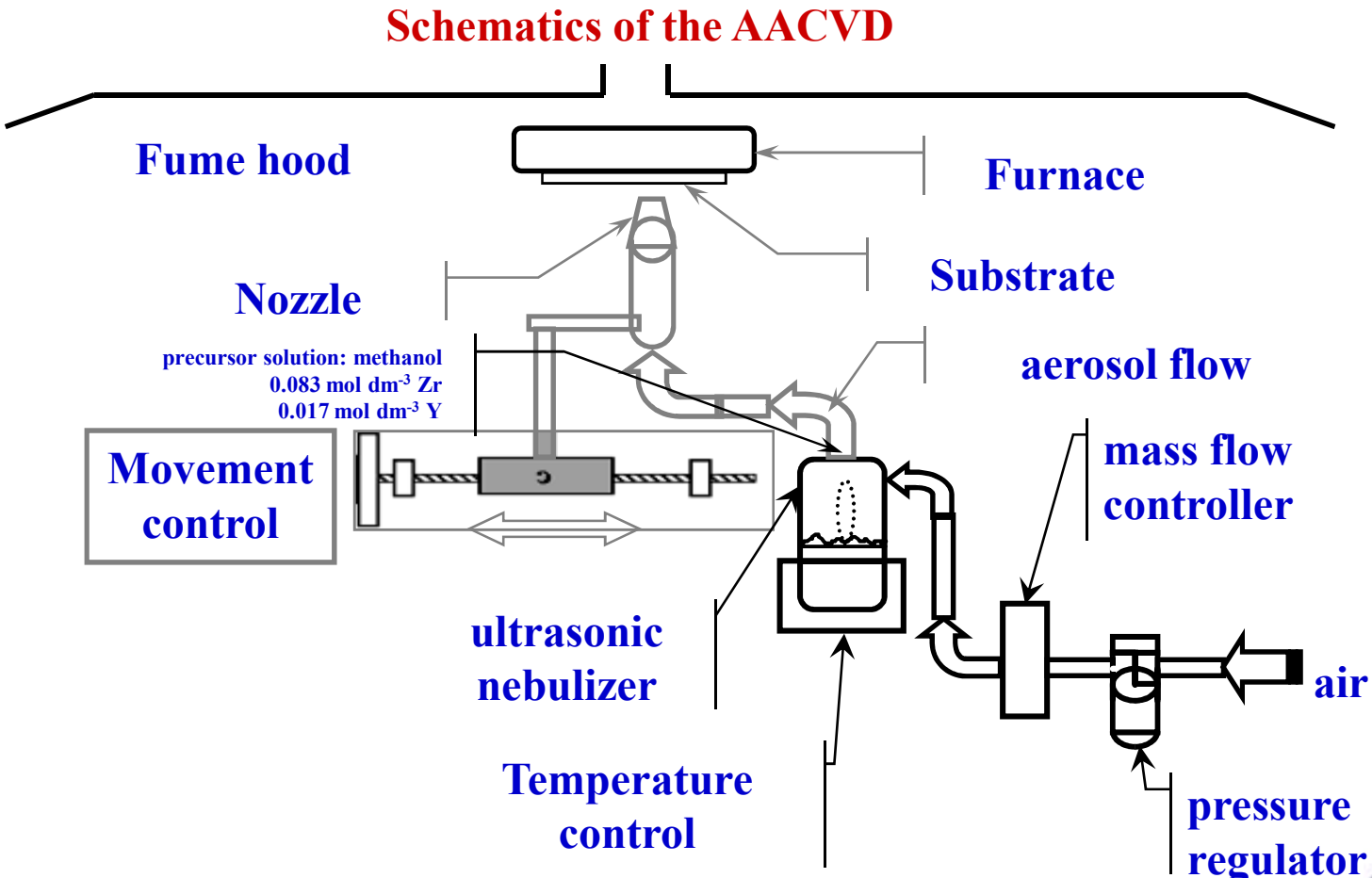


Potential Applications

- *Gas adsorbent*
- *Transparent electronics (ASU/CIMAV)*
- *Glass industry*

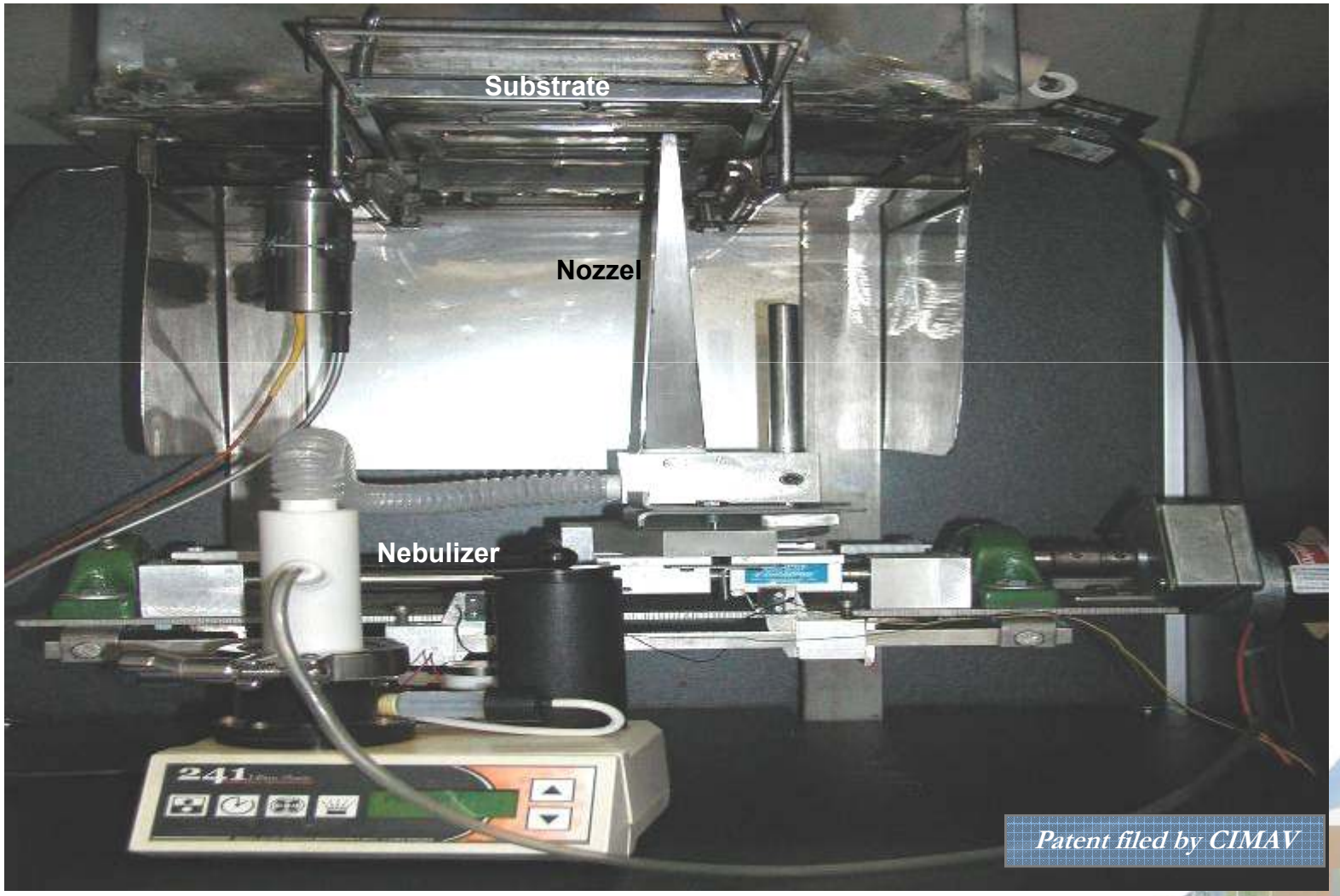
Aerosol Assisted Chemical Vapor Deposition

Application of Nanocoatings



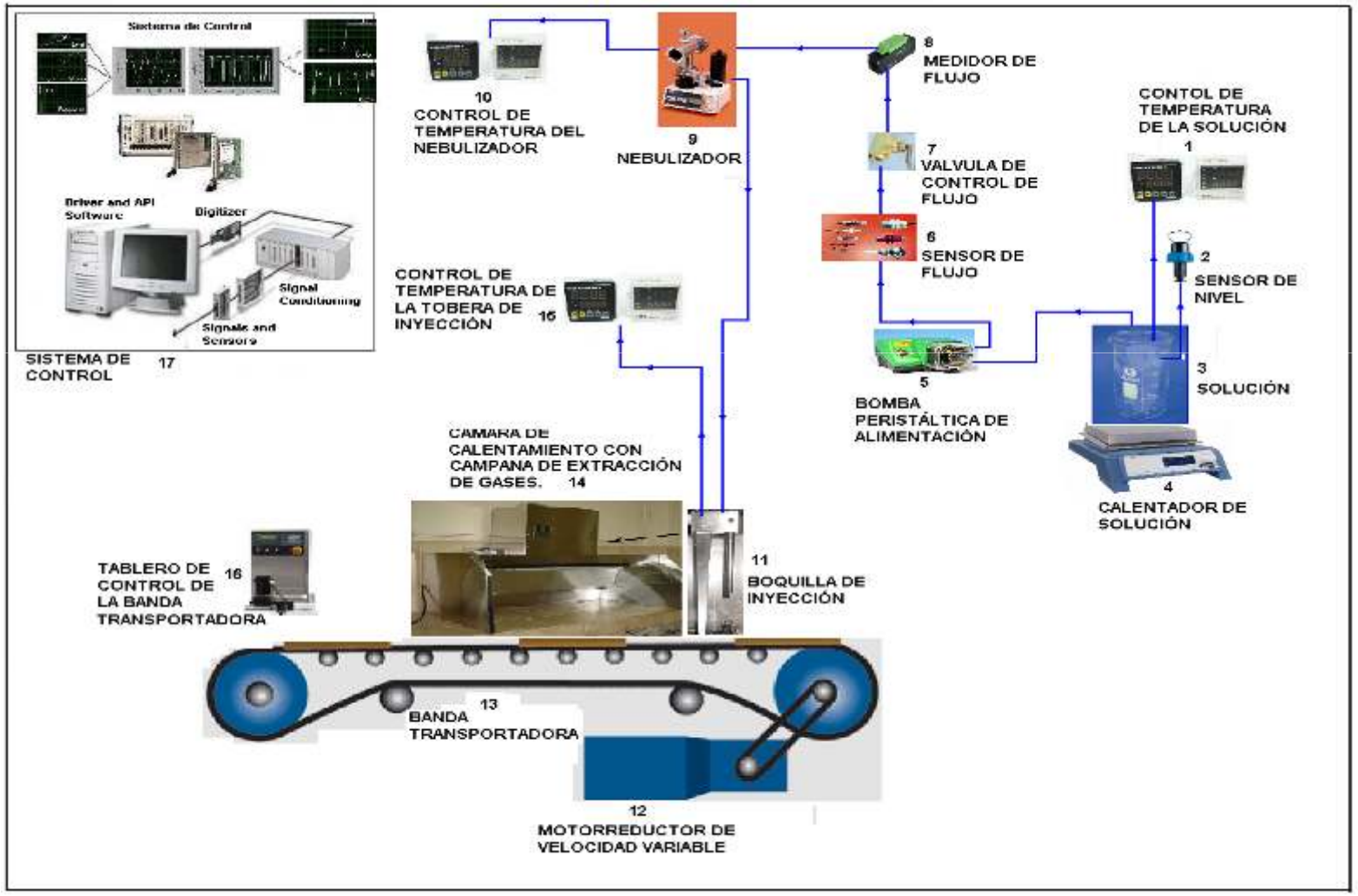
AACVD for Flat Surfaces

Laboratory prototipe



Patent filed by CIMAV

AACVD : Lay out of components



General Comments about Nanometrology

- *Metrology appropriate to nanoscale systems will be critical for the development of nanotechnology, both in terms of the fundamental scientific understanding of those systems and in terms of viable commercial activities*
- *It is widely accepted that no single technique will be able to provide all of the critical metrology for nanoscale systems*
- *Ongoing challenges reside in the development of instrumentation built with a level of sophistication sufficient to allow their use by scientists in all fields and in the development of physical understandings of the factors dictating the response of complex heterogeneous nanometer-scale systems*
- *Nanomanufacturing in the future will relay on fast in-line metrology tools for process control, backed up by more accurate tools on the manufacturing floor. Tools will be cost-effective, fast, suitable for mass production occupy minimal floor space, not require ultra-high vacuum or stringent vibration isolation and support appropriate work volumes. Real-time data will provide fast analysis and control of manufacturing process.*
- *Development that has the ability to characterize dense quantities of nanoelements under manufacturing conditions and manufacturing-relevant true spans*
- *Developing effective metrology that enables in-process measurements allows companies to take and important step towards achieving predictable product properties.*


Thank You