

NPL perspective: Development of documentary standards for the measurement and characterisation of nanotechnologies

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International Workshop on Nanotechnologies

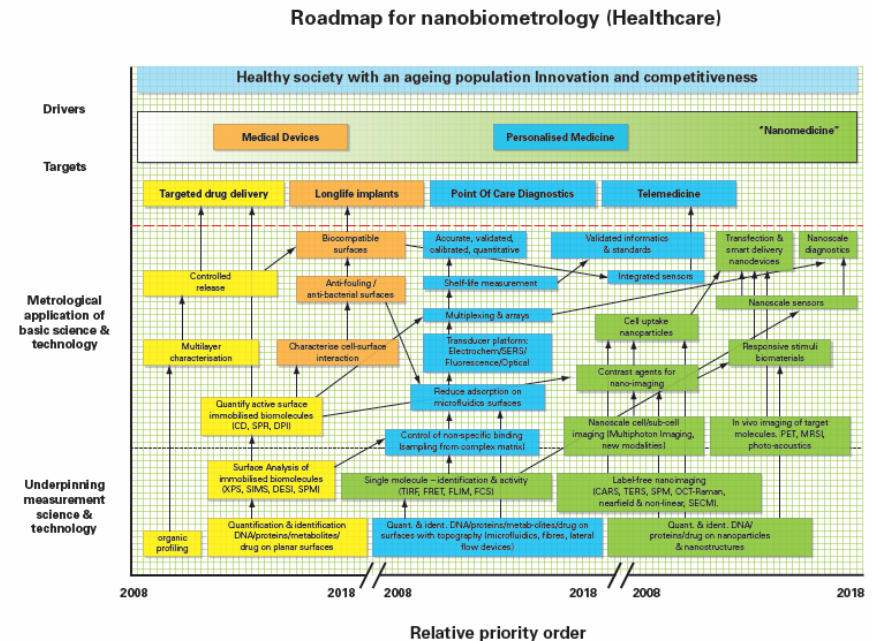
NIST, February 2008

EU NANO-STRAND

Standardisation related to Research and Development for Nanotechnologies

6 principal metrology themes

1. Nanodimensional
2. Nanomechanical
3. Nanostructured materials
4. Nanochemical
5. Nanobio
6. Nanoelectronics



Dimensional nanometrology

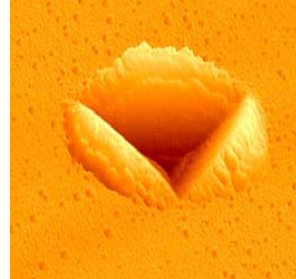


Current status

- Well-established capability for dimensional nanometrology – excellent international co-ordination.
- GPS (Geometrical product specification) key documentary standards used by NMIs for surface texture – wider uptake needed

Metrology gaps and needs

- Dimensional measurement of Nanoparticles.
- Accuracy at sub nm level over 3D space with mm dimensions.

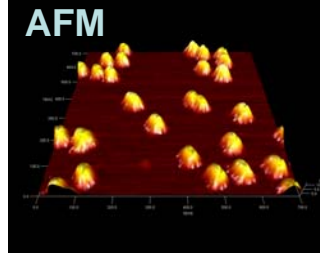


Current status

- AFM key tool. Prenormative (VAMAS TWA 22, TWA 29, TWA 2) and documentary standards underway (ISO TC 164, TC 201) – much to do.
- Underpinning metrology for contact mechanics being developed.

Metrology gaps and needs

- Force measurement - AFM spring constant calibration – normal and lateral.
- Indentation of complex materials (nanolayers, nanodomains, nanoparticle composites).
- Friction at the nanoscale – JKR, Amonton's, environment (water etc).



Current position

- Many established measurement techniques – strong prenormative (VAMAS) and ISO documentary standards.
- Multiple techniques are required, TEM, SPM, NEXAFS, XRR, XRD, NR, SANS, RBS, Atom Probe, He⁺ ion microprobe.

Metrology gaps and needs

- Nanoparticle and nanomaterial reference materials
- Nanoparticle characterisation in liquid, composite matrix, dry form.
- A coherent strategy is required to apply techniques to understand structure.
- SPM methods such as MFM, SCM, KPM.

Nanochemical

Current status

Strong metrology base.

Significant activity through prenormative (VAMAS TWA 2) and >50 standards and technical reports published.

AES, XPS, SIMS, SPM, TXRF, GDOES

Metrology gaps and needs

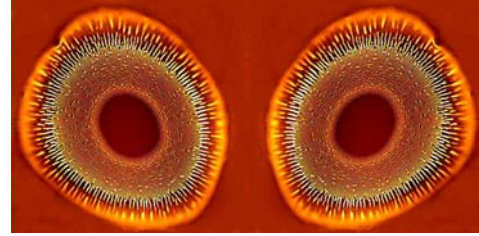
SPM (SNOM, AFM) calibration, reference materials, effects of environment, description of probes, cantilever calibration.

Surface analysis of nanostructured materials.

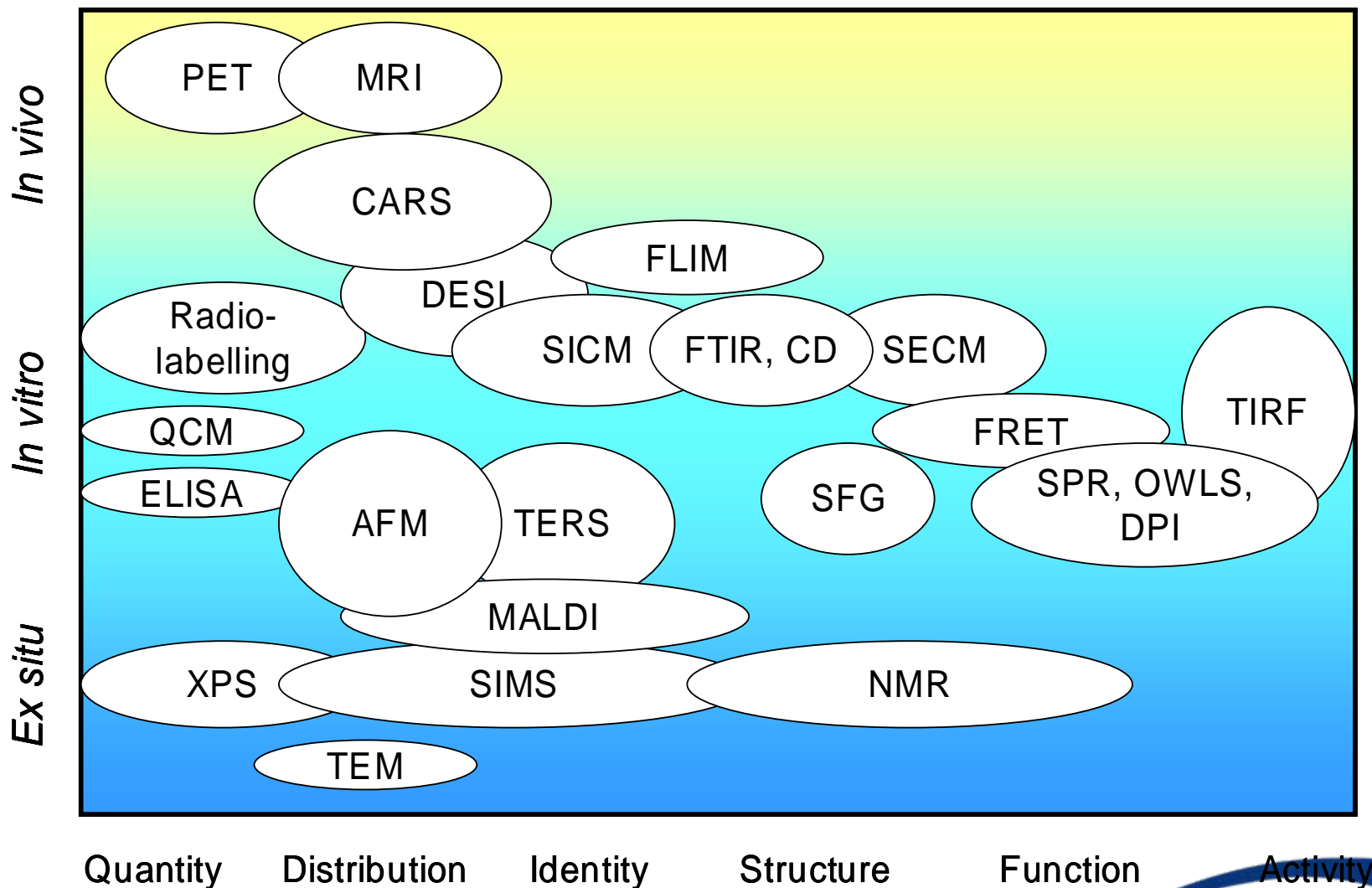
Organic and biological materials.

Nanoparticle characterisation (surface to core).

New techniques < 50 nm chemical analysis (TERS etc).



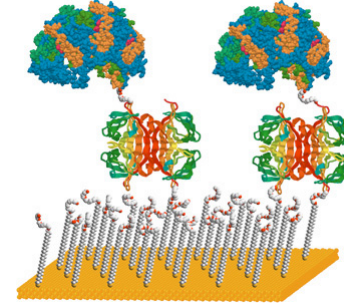
Nanobiometrology



Nanobio metrology

Current position

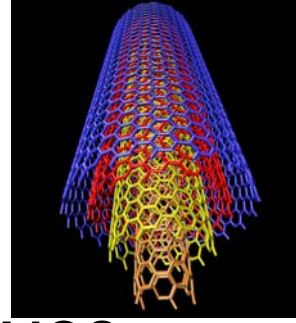
- NMIs establishing metrology.
- BIPM CCQM and JCTM (Joint Committee on Traceability in Laboratory Medicine) are a key focus of metrology for biotechnology – Roadmaps.
- Single molecule metrology.



Metrology gaps and needs

- Nanomedicine (European Technology Platform) major area for innovation and new therapeutics.
- Quantity, Structure, Function & Activity.
- Biochemical techniques that operate *ex situ* or *in vivo*
- Bioactivity of nanoparticles.
- Process Analytical Technologies driving physico-chemical measurement.
- Metrology to support IVD Directives.

Nanoelectrical metrology



Current position

Metrology and characterisation methods for Si-based extended CMOS devices – strained Si, high-k materials.

Metrology for novel systems, i.e (CNT quantised electrical and thermal conductance). IEEE standards for CNTs in development.

Single Electron Transport measurement.

Metrology gaps and needs

Quantum standards based on c , e and h using so called Quantum Metrological Triangle V , I , f .

Beyond CMOS – metrology for molecular electronics; molecules, CNTs, graphene and nanorods.

Quantum detection and sensors.

Summary

- NANO-STRAND reports standardisation related to Research and Development for Nanotechnologies – 6 themes
- NANO–STRAND Roadmaps summarise metrology development.
- Many requirements for nanometrology – nanoparticle characterisation, SPM documentary standards.