PIXE for biodistribution of nanomaterials and characterization of biological matrices

Category:
D. Nanomaterial exposure assesment

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Short technology description/Overview:

Particle-Induced X-ray Emission (PIXE) is a non-destructive technique used to determine the elemental concentration of the analysed sample. It relies on the use of an ion beam exciting the electronic levels of the atoms and thus producing X-ray emission. These X-rays are characteristic and proportional to every element and allow an easy identification and quantification of trace elements and the composition of the measured target (both the nanomaterials and its biological matrix).

Through a proper selection of ion beams, energies and filters it is possible to precisely quantify the biokinectics or biopersistence of nanomaterials present after in vivo* or in vitro exposure, and the elemental composition of the exposed tissues/cells/organs.

Advantages:

- No restriction of nanomaterial size: from a few nanometers and above.
- Ppm-levels of sensitivity (low background noise when compared to EDX).
- Label-free nanomaterials: no need for radiolabelling / radioactivation / fluorescence modifications to the nanomaterial that can potentially bias the observed response in the biological matrix.
- Ease of sample preparation: there is no need to condition the sample (i.e. digestion), besides getting a few droplets (if liquid) or making it a pellet (if solid).
- Big volume samples can be measured for statistical significance.
- Trace analysis of impurities of raw nanomaterials in either dispersion or solid forms.

* Rats exposure by instillation in a special inhalation device is possible at the FUNDP.

Main Features:

- Multi-elemental analysis (any element with an atomic number higher than Z=10).
- Solid and liquid samples: organs, tissues, emulsions, dispersions, culture media, inorganic matrices, radiolabeled / radioactivated / fluorescent nanomaterials, etc.
- Simultaneous elemental composition measurement of nanomaterials and biological matrix with ppm-levels of sensitivity.
- Fast, high sensitivity (ppm-levels) and high volume measurements (statistical significance).

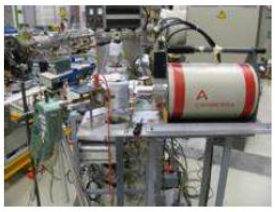
Limitations: The nanomaterial composition should not be the same as the matrix (or be in very low amounts). Example: SiO_X nanoparticles mixed in a silica dispersion.

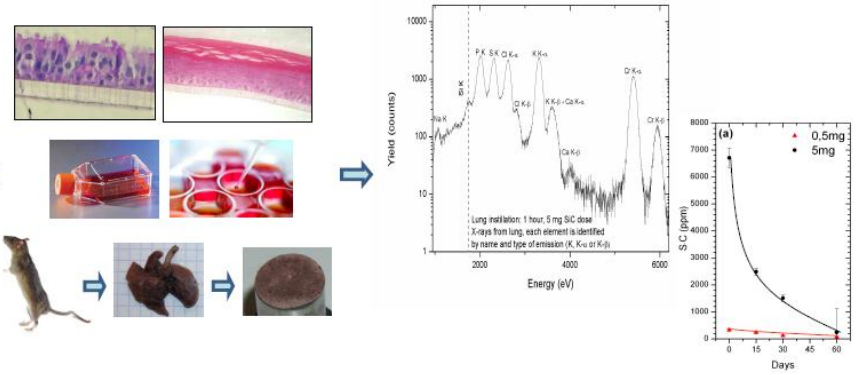
Typical Samples & Images:

PIXE: Nanomaterial exposure/characterization

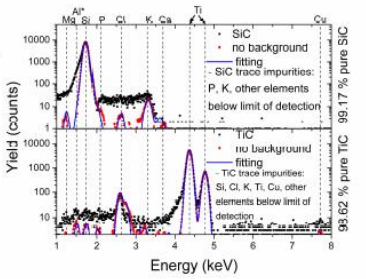
- Study of the biokinetics / biopersistance of nanomaterials in biological matrices (e.g. culture media, organs).
- Evolution of the elemental composition of biological matrices due to nanomaterial exposure.

PIXE setup





Characterization of the bulk composition of nanomaterials (powder or in dispersion). Study of nanomaterials trace impurities.



Further information:

Lozano O, Mejia J, Masereel B, Toussaint O, Lison D, Lucas S. 2011. Development of a PIXE analysis method for the determination of the biopersistence of SiC and TiC nanoparticles in rat lungs. Nanotoxicology (doi:10.3109/17435390.2011.572301)