Bio-detectors, applications for space

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IRAP - LAAS

Objectives: Detection and identifcation of **complex molecules** (biomolecules): Conception and development of innovative detectors for astrobiology.

Lab-on-Chip technology: fast evolving domain, mostly for medical application. Astonishing capabilities, a revolution for the detection of specific molecules

-> **Can this be adapted for space applications** ?

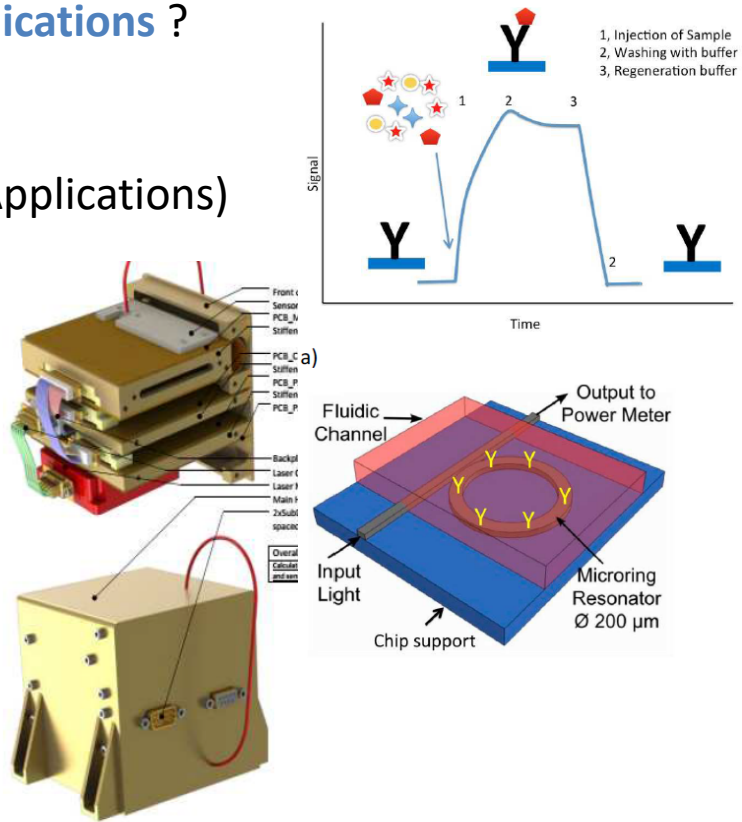
Example: **PBSA** prototype (Photonic Biosensor for Space Applications)

Pantoja et al, 2014

Photonic immunosensor. Antibody microarray-based immunosensor + photonic circuit and microfluidics.

Use the extreme binding properties of antibodies with target molecules. Functionalized surfaces. Classical for detection of contaminants.

Sensitive to very specific molecules



Different approach *(on-going development with CNES)*.

How can we combine 'high sensitivity' and 'universality' ?

Medical Bio-sensor: detection of a **very specific target**, among an extreme diversity of complex molecules (a droplet of blood…). Selectivity and selectivity are the keys

Space applications: different view. The target is unknown. The detection of any complex molecules (proteins, RNA, DNA…) would be a giant step. Sensitivity and versatility are the keys

Requirements for planetary applications:

1) Sensitivity > 10^{-15} mol/mol (Europa lander payload specification)

2) Capabilities of chemical analysis (unspecified target molecules)

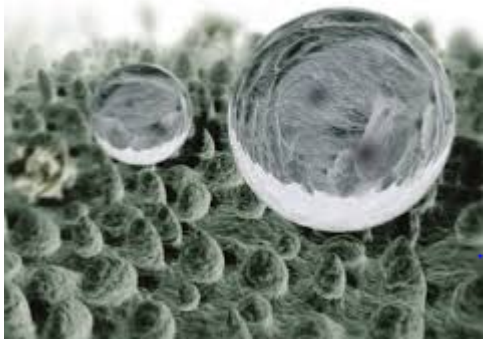
Promissing technics:

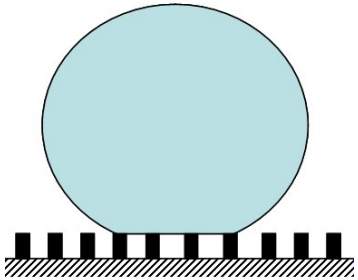
1) Use of Super Hydrophobic surfaces (SHS) – *for extreme concentration by evaporation of the solution.*

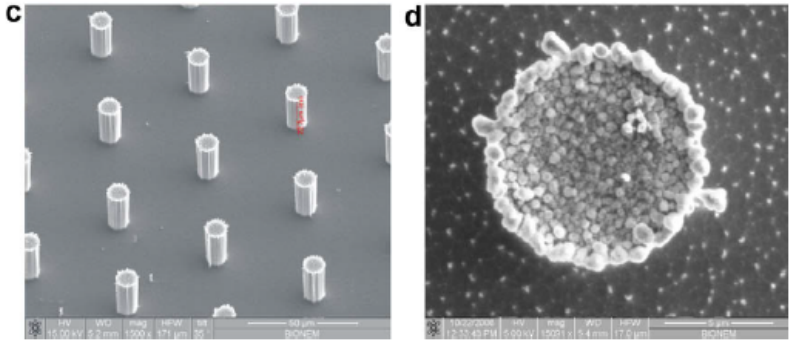
2) Detection par 'exalted' Raman – (SERS - Surface Exalted Raman Spectroscopy) – *for a versatile and sensible detection of a large variety of chemical compounds*

Super Hydrophobe Surface. Micro/Nano structured surface. 'Micropillar'.

After evaporation, the 'biomolecules' are deposited on small specified surfaces…

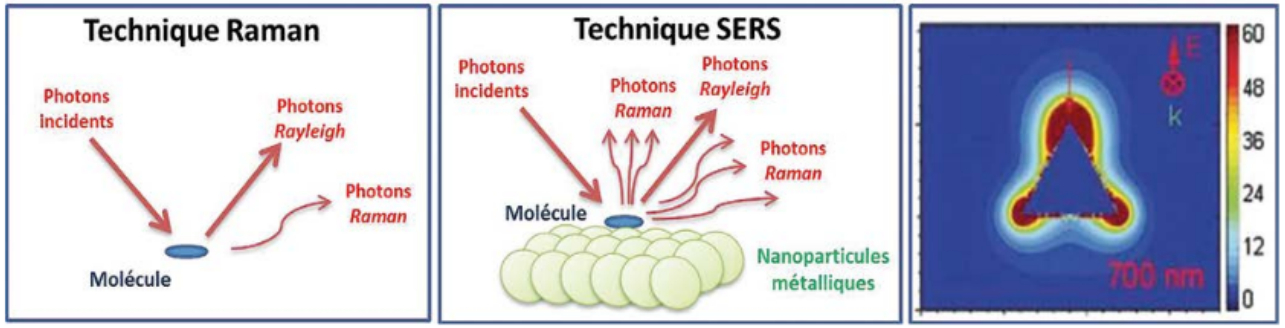






Exalted Raman. Strong amplification (10^6) of Raman signal at metallic nanoparticle layers.

Possibility of detection of single molecule !



Combining the 2 technics, a sensitivity of 10^{-18} mol/mol has been reported !

In Situ X-ray Scattering Studies of Protein Solution Droplets Drying on Micro- and Nanopatterned Superhydrophobic PMMA Surfaces

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