Development of Multisensing system for Contaminant of Emerging Concern in water

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Mission
During the years the Institute has reached the scientific excellence in Italy in the fields of macromolecular chemistry, physics and technology. The ISMAC research groups are active in the research areas related to synthesis, properties, characterization of synthetic and biological macromolecules and their applications in life science, rubber technology, advanced textiles, optoelectronics and packaging.

Organization
• Headquarter Milan
• Section of Biella
• Section of Genoa
Research activities at the section of Genoa

Advanced polymer Formulation and Characterization

Food packaging

Protein-protein interactions In pathological process

Biopolymers Structural and functional Analysis of protein and Nucleic Acids

Nucleic acids interactions with proteins and ligands
Expertise (Genoa Section):
ISMAC expertises include experimental competences for chemical characterization of substances and polymeric scaffolds and computational design of synthetic biopolymer (peptide Nucleic acids) and prediction (Docking) of binding affinity between ligands and biopolymeric targets (Proteins and Nucleic Acids)

Scientific Collaboration (Genoa Section)
There are different collaboration both international and National Russian Academy of Science (Siberian Branch), University of Bielefeld, University of Hyderabad, CSIR NEERI University of Genoa, University di Pavia, Ligurian Regional Government (Public Health Dept),Institute Polytechnique de Grenoble,CNR-IBAF

Recent research Projects
• Italian Ministry of Health on doping in young athletes (2015-2016),
• EU TECO project
• bilateral project CNR-CSIR (2014-2015)
• Italian Ministry of University and Research PRIN Proxi (2013-2016) [PaolaStagnaro]
• Regional Government of Liguria Health Dept. ‘Monitoring of metabolic damage in addicted peoples” (2016-2018)
• Polycom design and test of High density polymer San Paolo Foundation (2016-2018)
• Hybridjoin Advanced welding system National POR-FESR funding
• Work in Progress: collaboration with CNR-IBAF for design and implementation of a SERS based aptamer based system for wastewater monitoring.


The personal experiences, valuable for collaborative researches, is focused on development and use of Computational methods in the following areas:

1. Identification of critical elements of metabolic pathways targeted by pollutants
2. Design of Synthetic Nucleic Acid sensors and optimization of sensing specificity
3. Selection and Characterization of scaffolds for sensing probe
4. Design and test of Chemically modified probes
Contaminants of Emerging Concern (CEC) are chemicals not previously detected in environment. The following groups are those more critical to be removed:

- Endocrine Disruptors
- Pharmaceuticals and personal care products (including illicit drugs and veterinary pharmaceuticals)
- Food additives.

Development and test of a system capable to simultaneously monitor the presence of selected CEC after cleaning processes for drinkable water and for agricultural utilizations.
The challenge to monitor pollutant mixture of CEC

- Many new pollutants are produced by new industrial activities such as Pharmaceutical and nanotechnology.

- In many cases the mitigation and cleaning technologies are not easily adaptable to the chemical characteristics of CEC.

- The knowledge about the possible existence of detrimental synergism among different components in a ‘real world’ mixture of pollutants is not adequate.

- The effects of geological and climatological context on degradation and emergence of above mentioned harmful cooperative effects need also to be more deeply investigated.
Biosensors

- Receptors
  - Antibodies
  - Enzymes
  - Nucleic Acid
  - Cells

- Transducers
  - Electrochemical
  - Mass sensitive
  - Optical
  - Thermal

Summary of Biosensor Organization

Examples of different Biosensors
Examples of complexes of Nucleic Acid based sensors with two different Contaminant of Emerging Concern.

Nucleic Acid Sensor bound to the Diethyl-phtalate

Synthetic Nucleic Acid bound to the Tetracycline
Development and implementation of easy to use and portable system to monitor multiple component of Contaminant of Emerging Concern. The proposal is based on the technologies used for monitoring patients in hospitals or in remote assistance centers (Point of Care)

Hyungsoon Im et al. PNAS 2015;112:5613-5618
Architecture of Portable SERS based monitoring system
Application of the system

Example of Application

1. Integration in a precision farming application system
2. Monitor the industrial wastewater outlet or Quality control of water purification processes
3. Analysis of time course of pollution dynamic related with geo-climatological changes

Potential Users

1. Governmental bodies in charge for environmental monitoring
2. Companies involved in the design of remediation techniques
3. Farmers and Breeders to control the quality of water for livestock and irrigation
4. Fish farms
5. Chemical and pharmaceutical industries to control their wastewater.
Thank You