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Novel nanomaterial for lab on chip devices development: application to environmental stressors in food system and their effect on the oxidative stress in select cell

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Introduction

Oxidative Stress

- Imbalance between oxidant stressors and antioxidant defenses
- Leads to several diseases such cancer, ischemia, atherosclerosis, aging, Parkinson's and Alzheimer's disease

Antioxidants

- The major antioxidants defenses are composed by antioxidant enzymes such as SOD, CAT, GTPx, TRX, PRX and GST however dietary antioxidants could add significant defenses against oxidant stressors
- Antioxidant therapy needs further investigation to understand the connections between ROS levels, diet and disease

Nanomaterials/Microfluidics

- Nanomaterials shows improved characteristics compared with their macroscopic counterparts allowing to improve LOD, sensitivity and selectivity
- Microfluidics provides miniaturization of laboratory components allowing the "lab-on-a-chip" technology with a negligible sample consumption and better performance
- This technology could pave the way for decentralized analysis of ROS and antioxidant in µTAS and point-of-care and for studying the effectiveness of antioxidative therapeutic strategies

Milestones

Development and characterization of new NMs for Oxidative Stress (bio)markers sensing applications

↓

Integrate the NMs in microfluidics platforms interfaced with cell cultures

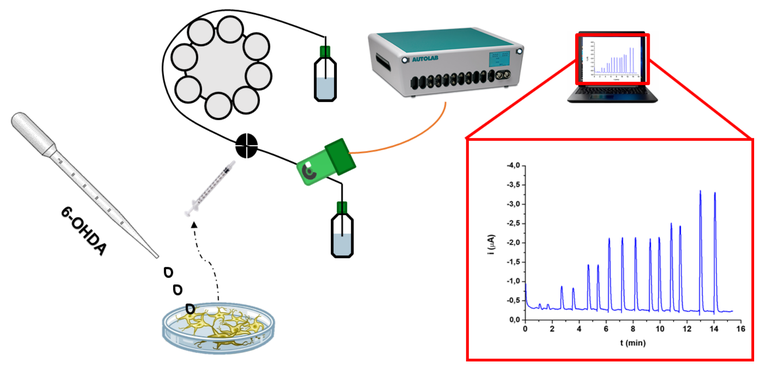
↓

To test the microfluidic platform in different cell cultures

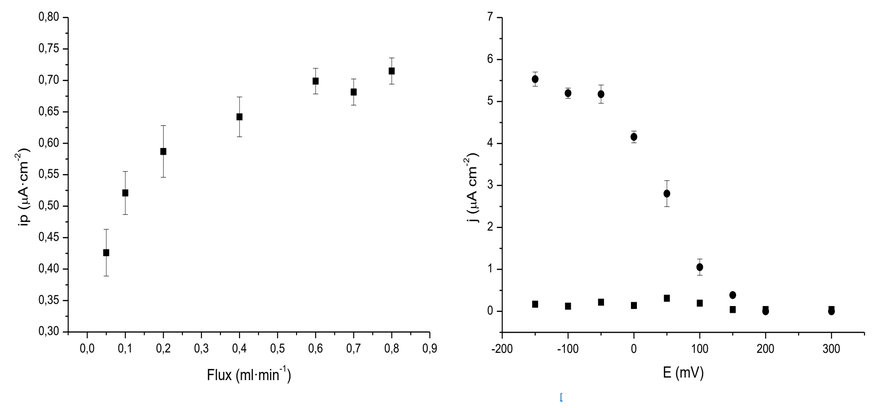
Training

Course name	Description	ECTS
Italian Language Course	Basic Italian Language course corresponding to A1 level (CEFR)	4
First National School on Chemical Sensors	Presentation of main methodological innovations in the development and application of (bio)sensors	4
Effective Proposal Writing	Focused on research proposal writing	1
Summer School on Smartphone-based food analysis	Providing detailed knowledge of the state of the art and practical aspects to open the way for future applications of smartphones in (bio)sensing applications	2
Statistics and laboratory data collection	General statistics course covering probability, descriptive and inferential statistics, correlation and regression, grouping and clustering	5
Homogeneous assays for biomarker quantification and interaction studies	This course is focused on the theory of Alpha and LANCE technologies and their applications followed by an experimental session to directly familiarize with these technologies.	1
		17 ECTS (57% of the total)

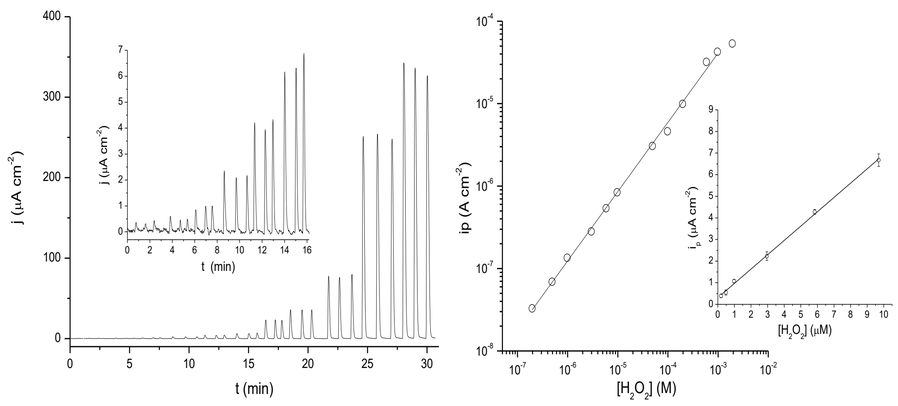
Results



Scheme of the experimental set up



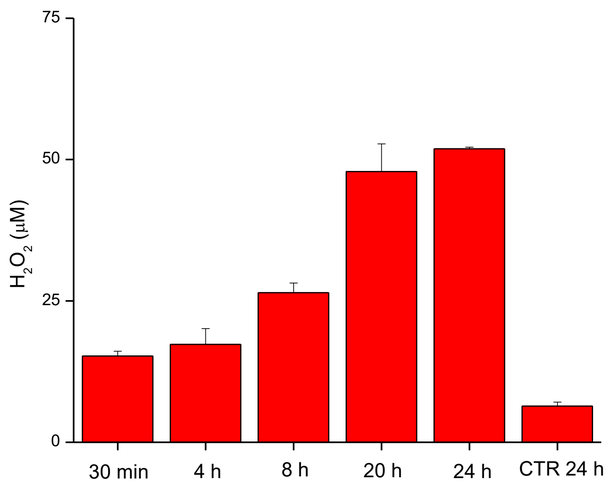
FIA optimization and Hydrodynamic Voltammetry



Analytical Signals and Calibration Plot

LOD (µM)	Linear range (µM)	Sensitivity (A M^{-1} cm^{-2})	Detection potential (mV)
0.02	0.2-1000	0.66	-50

Analytical Performance



H_2O_2 levels in SHSY5Y differentiated in neurons cell cultures.

Dissemination

These results will be presented in oral communication in the 4th National Meeting in Sensors (4º Convegno Nazionale di Sensori) in Catania the 22 of February. This means complete the 50% of the mandatory short communications

Communication

- Radio interviews
- "Bioscience Summer School: RepEat Ambassadors for young students"

Conclusions

- Combination of NMs was developed for H_2O_2 sensing in a wide range, very low LOD and interference free.
- The nanomaterial was succesfully applied for H_2O_2 sensing in SHSY5Y differentiated in neurons cell cultures.

Future work

- Keep on working with the developed sensor on the Parkinson's disease model in different conditions.
- Test the developed sensor in different cell cultures.
- Exploration of new nanomaterials and its application on electrochemical/optical sensing of oxidative stress (bio)markers and/or antioxidants sensing.
- Integrate the sensor in microfluidics platforms

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References

1. Sies H, Berndt C, Jones DP. Oxidative Stress. Annu Rev Biochem. 2017;86(1):715–48.
2. Umeno A, Biju V, Yoshida Y. In vivo ROS production and use of oxidative stress- derived biomarkers to detect the onset of diseases such as Alzheimer ' s disease , Parkinson ' s disease , and diabetes. 2017;5762(October).
3. Pisoschi AM, Pop A. The role of antioxidants in the chemistry of oxidative stress: A review. Eur J Med Chem. 2015;97:55–74.
4. Liu H, Weng L, Yang C. A review on nanomaterial-based electrochemical sensors for H_2O_2 ,H_2S and NO inside cells or released by cells. Microchim Acta. 2017;184(5):1267–83.
5. Ortiz P, Munoz-Berbel X, Gonzalo-Ruiz J. Microfluidics for Monitoring Oxidative Stress and Antioxidant Capacity. Curr Anal Chem. 2012;8:456–71.
6. Wu J, He Z, Chen Q, Lin J-M. Biochemical analysis on microfluidic chips. TrAC Trends Anal Chem. 2016 Jun 1;80:213–31.