PRODUZIONE DI IDROGENO E ABBATTIMENTO DI INQUINANTI IN CELLE SOLARI FOTO-ELETTRO-SINTETICHE

Fare i conti con l'ambiente
Rifiuti acqua energia

Ravenna 2018
16·17·18 maggio

HP SOLAR
HIGH PERFORMANCE SOLAR DECONTAMINATION

Workshop O

HP-Solar High Performance
Solar Decontamination

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Il progetto

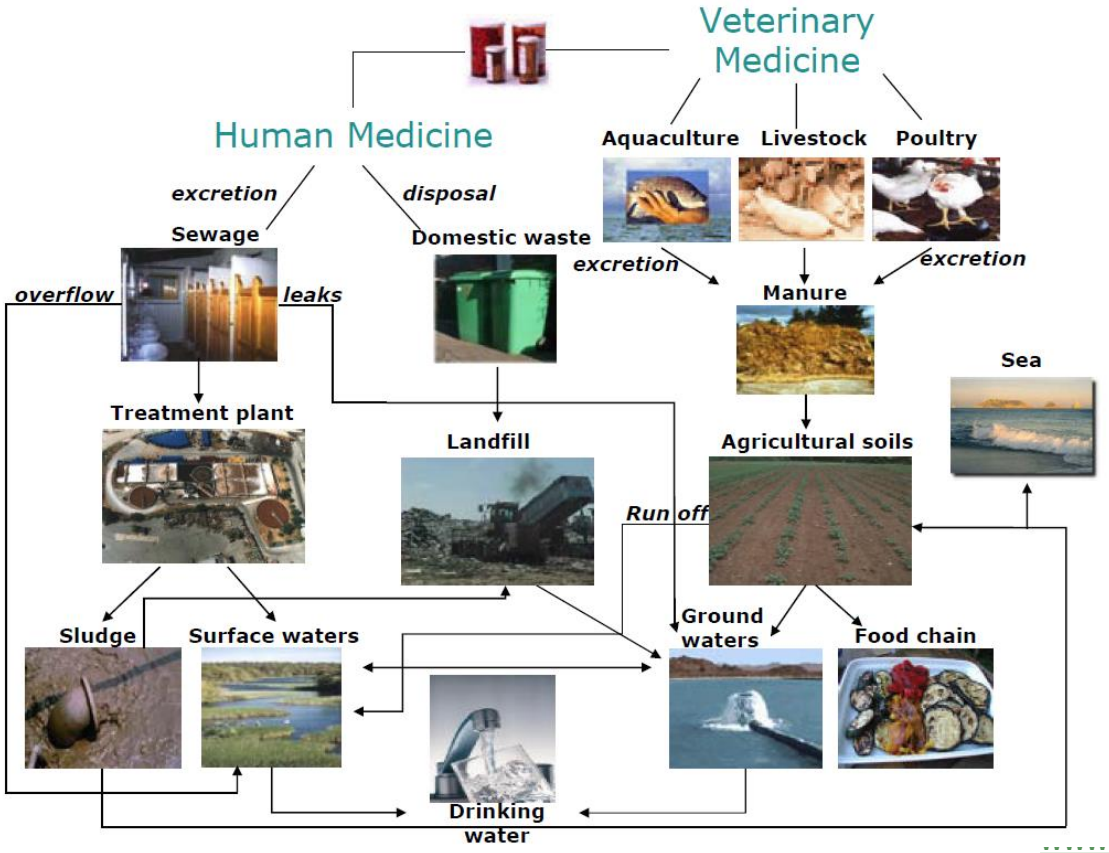
La finalità

Coniugare sistemi di depurazione ambientali e conversione di energia solare in energia chimica immagazzinata sotto forma di combustibili puliti come l'idrogeno è l'obiettivo di HP-SOLAR, progetto che si sviluppa sull'idea di rendere la **depurazione delle acque di scarico** non solo produttiva dal punto di vista energetico ma anche ambientalmente ed economicamente sostenibile.

Il progetto recepisce gli obiettivi di **crescita intelligente, sostenibile ed inclusiva** attraverso ricerca industriale svolta nell'ambito di uno dei pillar della **ricerca EU** (Politiche di coesione EU e sfide della società di Horizon 2020): le tematiche di **fonti energetiche alternative, salvaguardia della risorsa idrica e la minimizzazione di impatto ambientale** proprie di questo progetto sono infatti riconosciute in ambito EU come fondanti per la realizzazione degli obiettivi strategici

Depurazione delle acque e contaminanti emergenti

Molti composti di uso quotidiano (farmaci, prodotti per la cura e l'igiene personale) non sono completamente rimossi dagli impianti di trattamento e/o potabilizzazione



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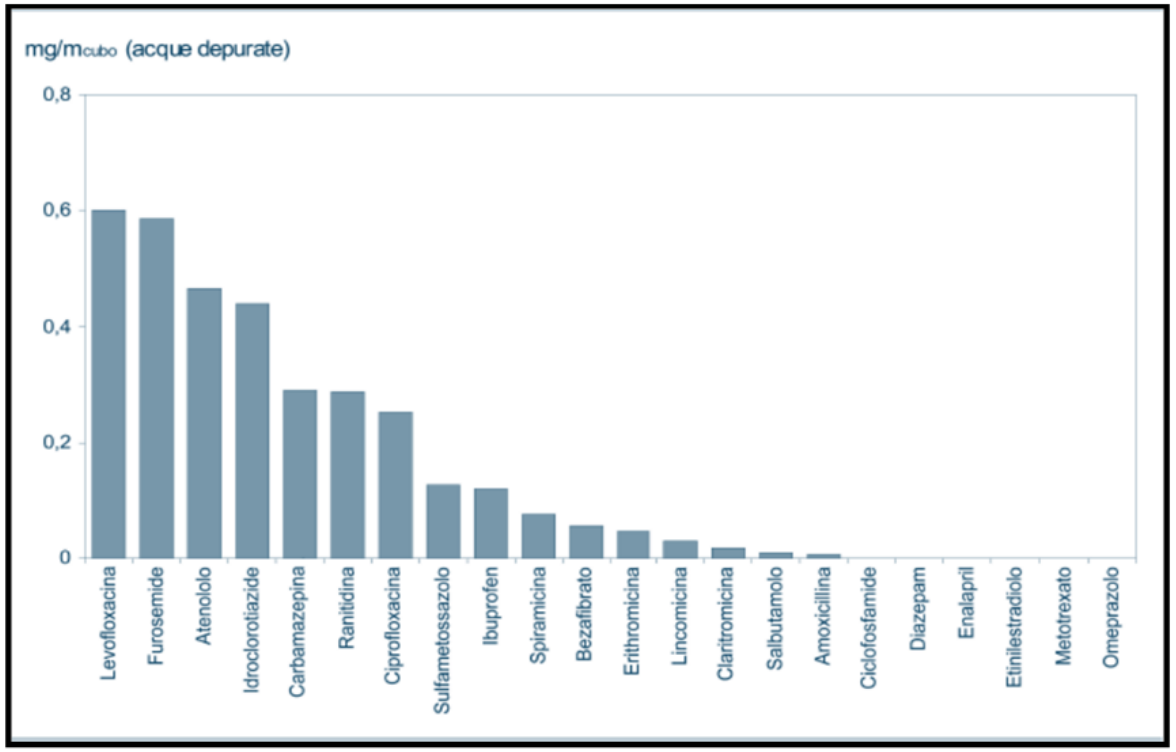
Milano, 30 Gennaio 2018
Studio dell'Istituto Mario Negri, finanziato da Fondazione Cariplo, sui nuovi inquinanti nel sistema acquifero milanese

Ogni anno, Milano scarica nei corsi d'acqua metropolitani 2,5 tonnellate di farmaci, 1,6 quintali di droghe d'abuso, quasi mezza tonnellata di prodotti chimici per la cura della persona

Potabilizzazione delle acque e i nuovi inquinanti emergenti

Farmaci presenti negli effluenti in uscita di alcuni impianti di depurazione in Italia (media di 9 depuratori)



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Potabilizzazione delle acque e i nuovi inquinanti emergenti

Percentuale di Eliminazione nei comuni impianti di trattamento delle acque reflue

Compound	Removal
Carbamezapine (anti-epileptic drug) Atenolol, Metoprolol (β-blockers) Trimethoprim (antibiotic)	< 10 % (no removal)
Diclofenac (anti-inflammatory)	10-39%
Methoxazole	50%
Gemfibrozil (lipid regulator)	43-71%
Naproxen (anti-inflammatory)	42-92%
Fluoroquinolones (antibiotics)	60%
Ibuprofen (anti-inflammatory)	> 90% Note: hydroxy and carboxy metabolites found in effluents)

Laboratori ed Imprese Partecipanti

- Terra&Acqua Tech
- Tecnopolo TekneHub
- HERA
- ITALIA ENERGIA

Italia Energia Srl

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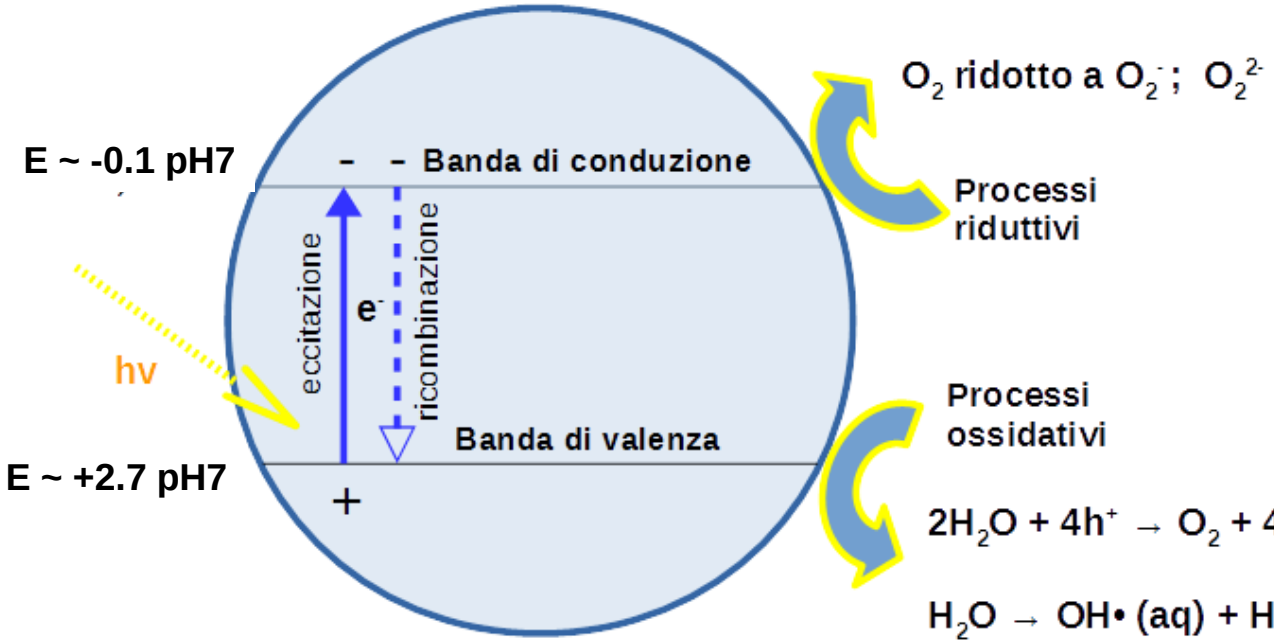
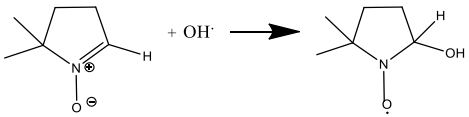
Ricercatori coinvolti nel progetto HP-Solar

Vito Cristino	Chimica
Elisabetta Benazzi	Chimica
Claudia Stevanin	Chimica
Micol Boschetti	Fisica
Alfredo Andreoli	Fisica
Paolo Bernardoni	Fisica
Daniele Pazzi	Microbiologia
Ugo Rizzo	Economia
Francesco Nicolli	Economia
Massimiliano Mazzanti	Economia

Semiconduttori: il WO_3 e la Foto-Ossidazione degli inquinanti



EPR: Electron Paramagnetic Resonance



DMPO DMPO-OH·

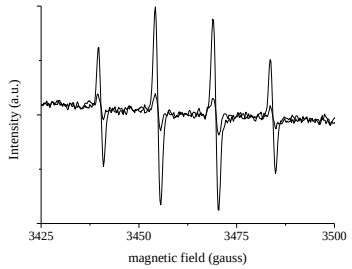


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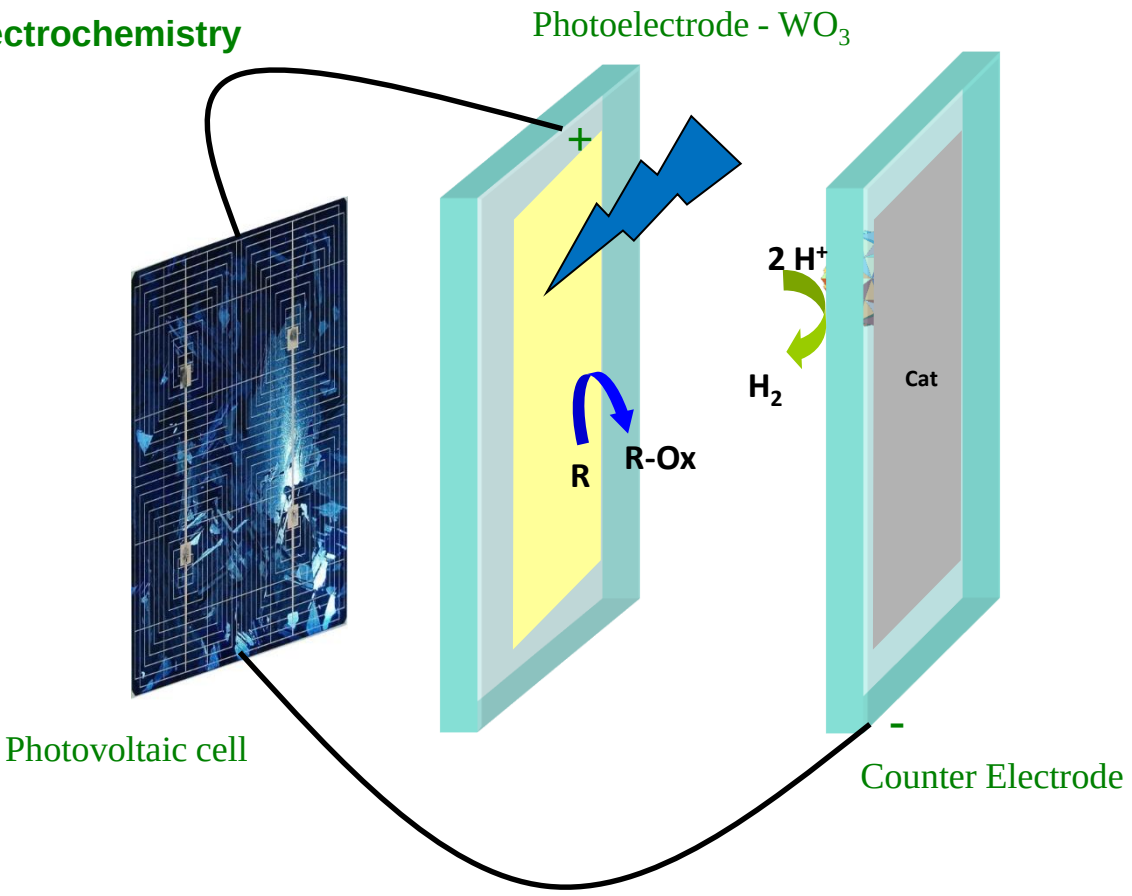
Photo-Electrochemistry



Storage of solar energy into a clean fuel (H_2) through organic degradation

Miscelando i prodotti dei comparti anodico e catodico

$$C(-4) + O_2 \longrightarrow CO_2 + 4\,e^-$$

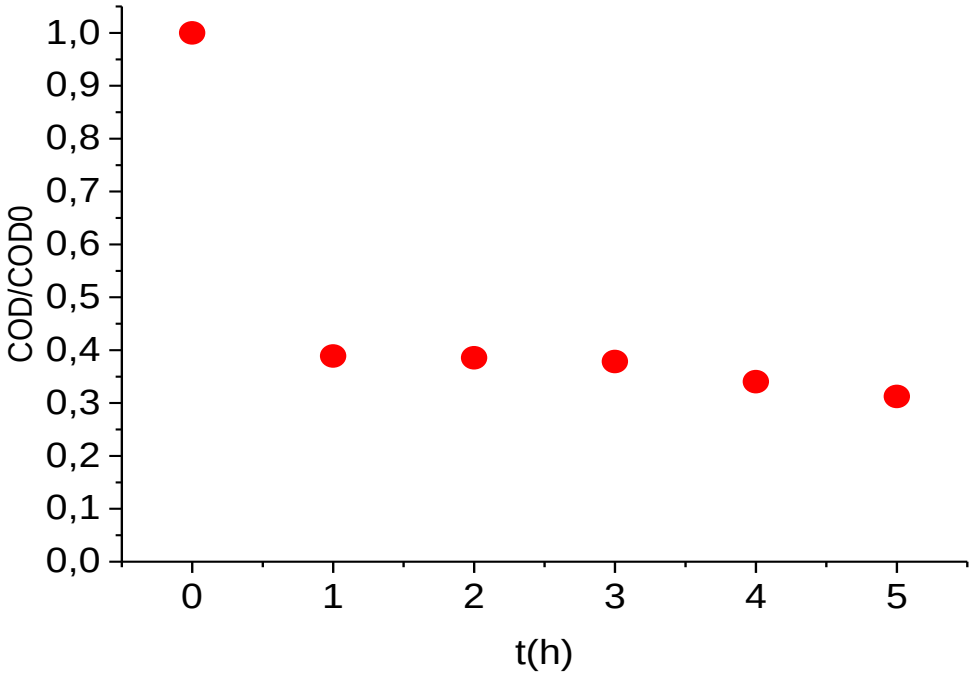
$$4H_2O + 4e^- \longrightarrow 2H_2 + 4OH^-$$

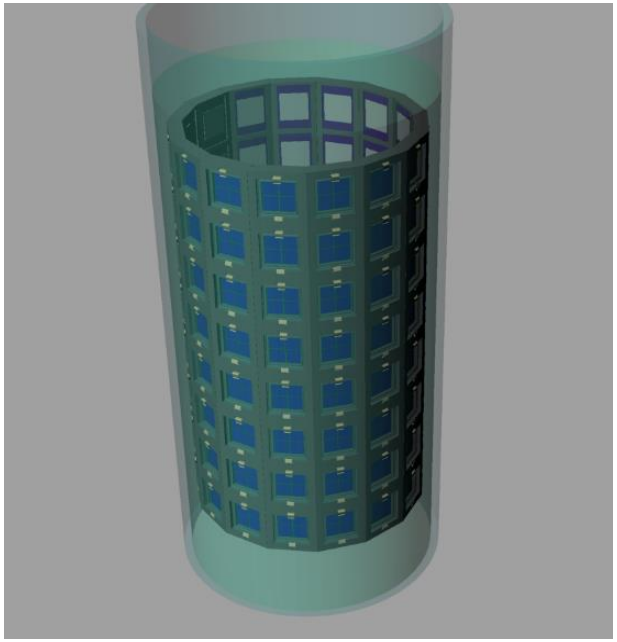
$$2H_2 + CO_2 \longrightarrow CO + H_2$$

$$H_2 + CO \longrightarrow \text{Alcoli, Aldeidi, Idrocarburi}$$

Abbattimento COD e produzione di idrogeno dalle acque reflue

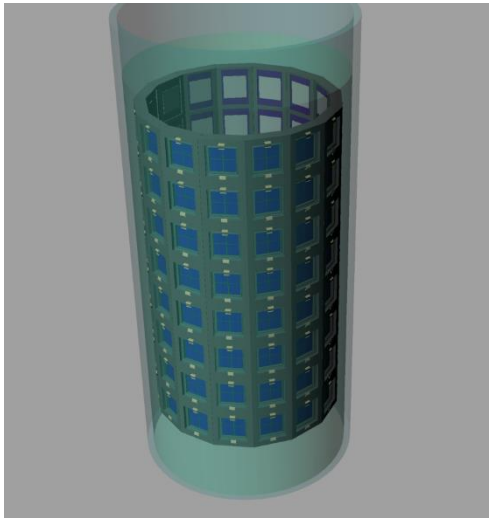
Abbattimento del COD in acque reflue civili



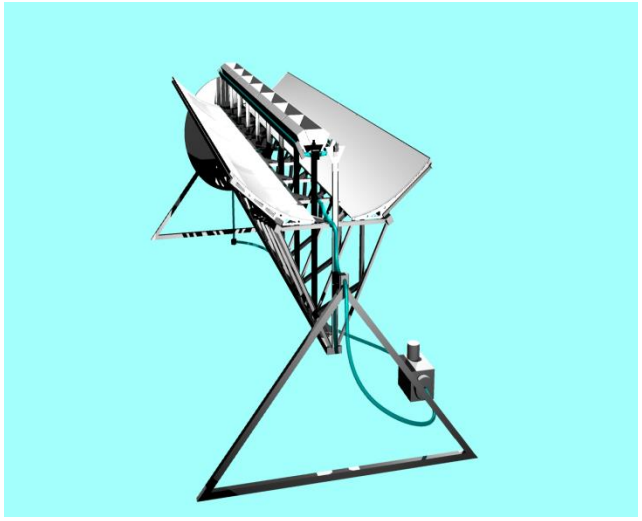


Dispositivi Fotoelettrochimici e Fotocatalitici Basati su Ossido di Tungsteno - WO_3

Produzione di Idrogeno da acque di scarico



Decontaminazione di acque Potabili da inquinanti emergenti



Decontaminazione di acque potabili da batteri

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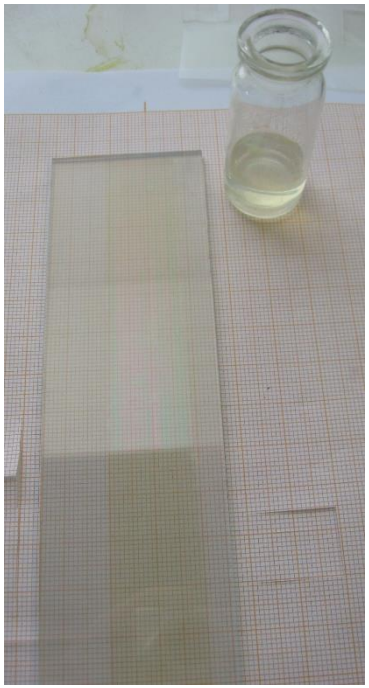
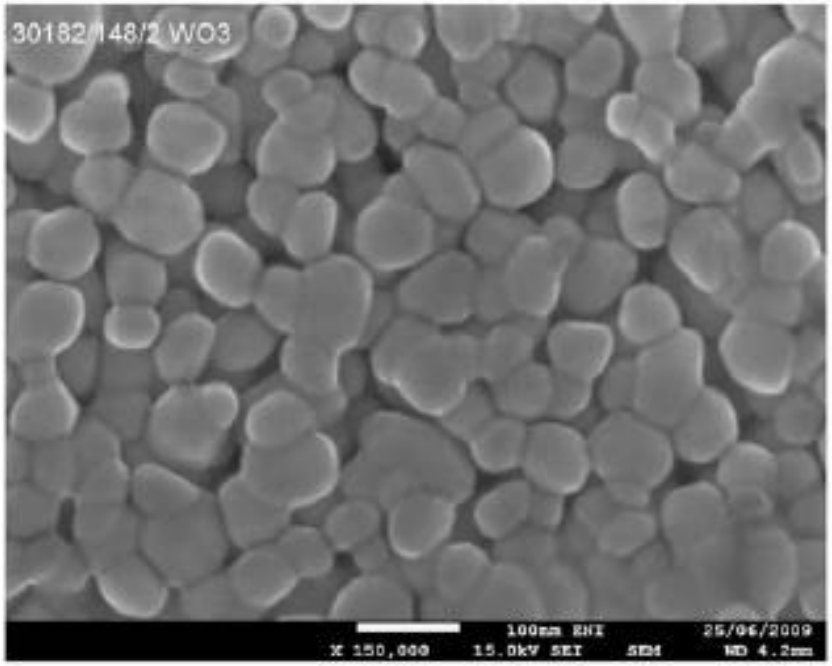
WO_3 Sol-Gel





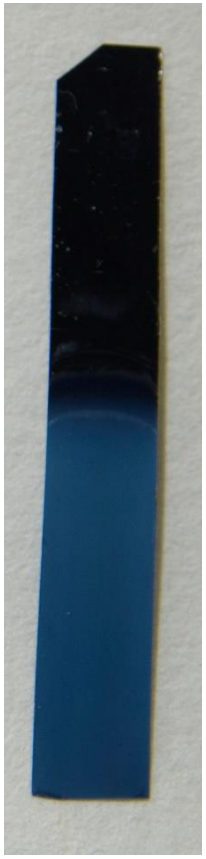
$Na_2WO_4 + 2\ HCl \rightarrow H_2WO_4 + 2\ NaCl$

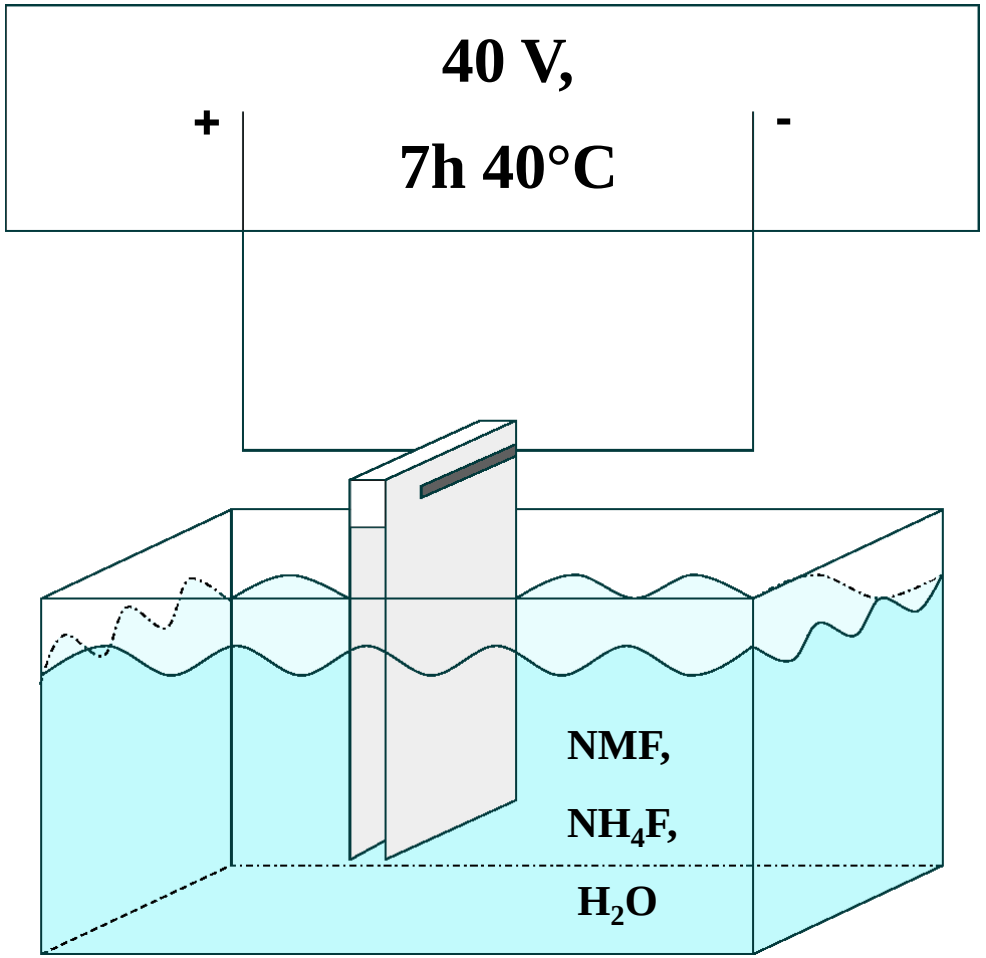
$H_2WO_4 \rightarrow WO_3 + H_2O$

30-100 nm

nanoparticelle

WO_3 anodizzato





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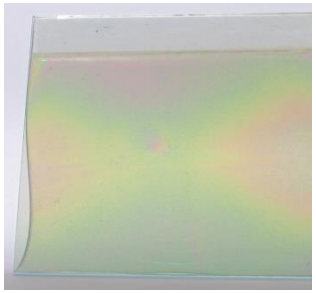
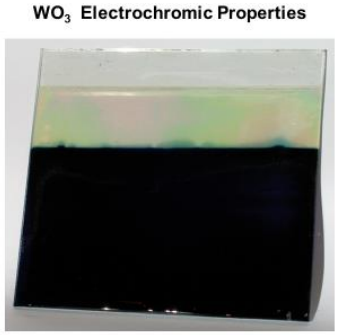
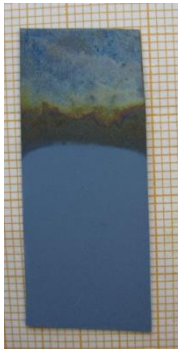
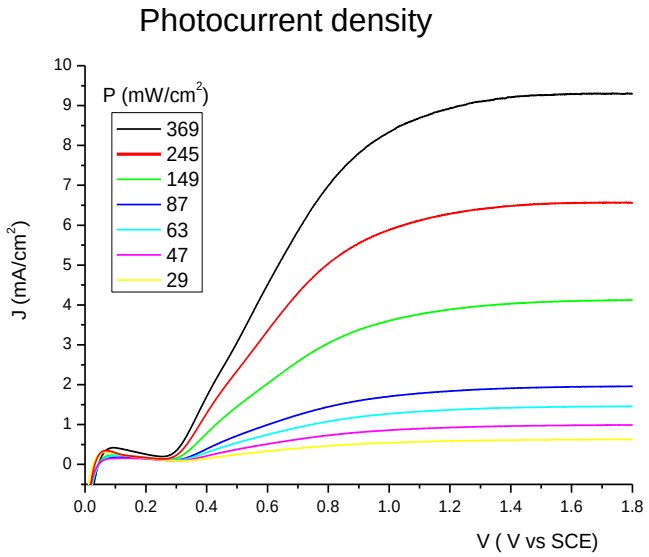
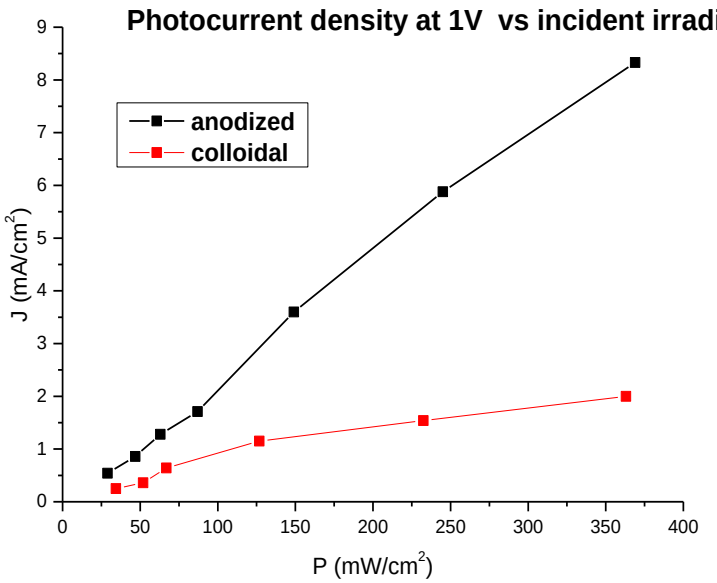
Efficienza dell'Ossido Tungstico in concentrazione solare











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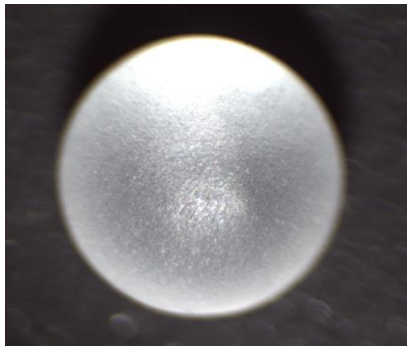
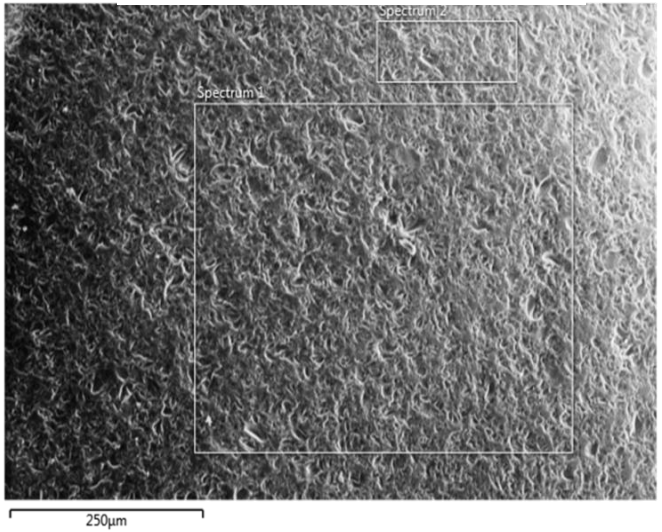
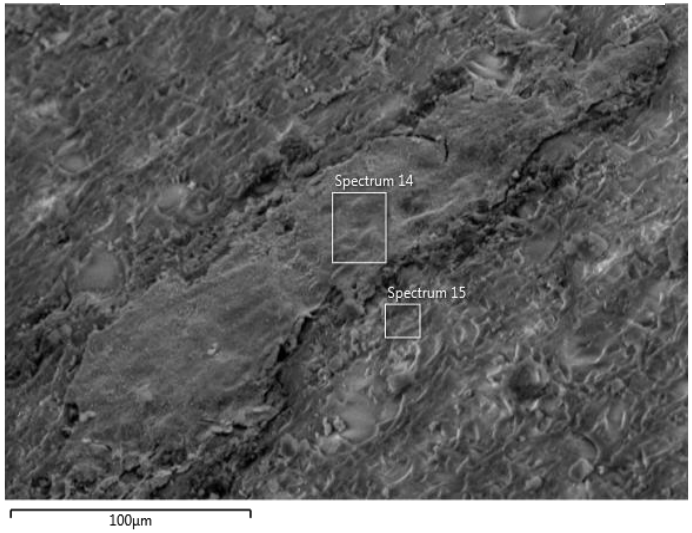
WO_3 depositato su sfere

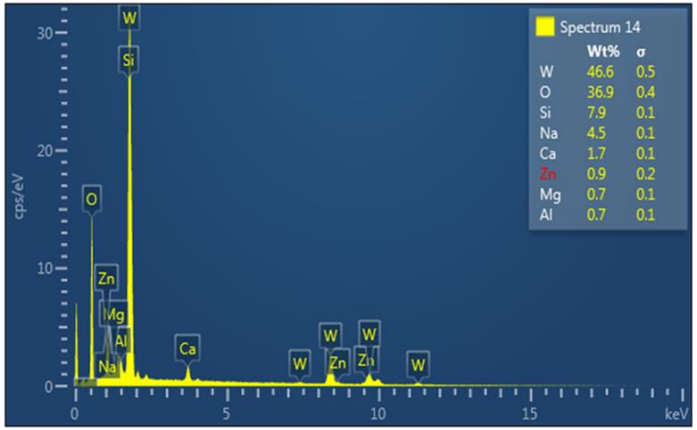


Immegine SEM Sfera



Immegine SEM Sfera + WO_3





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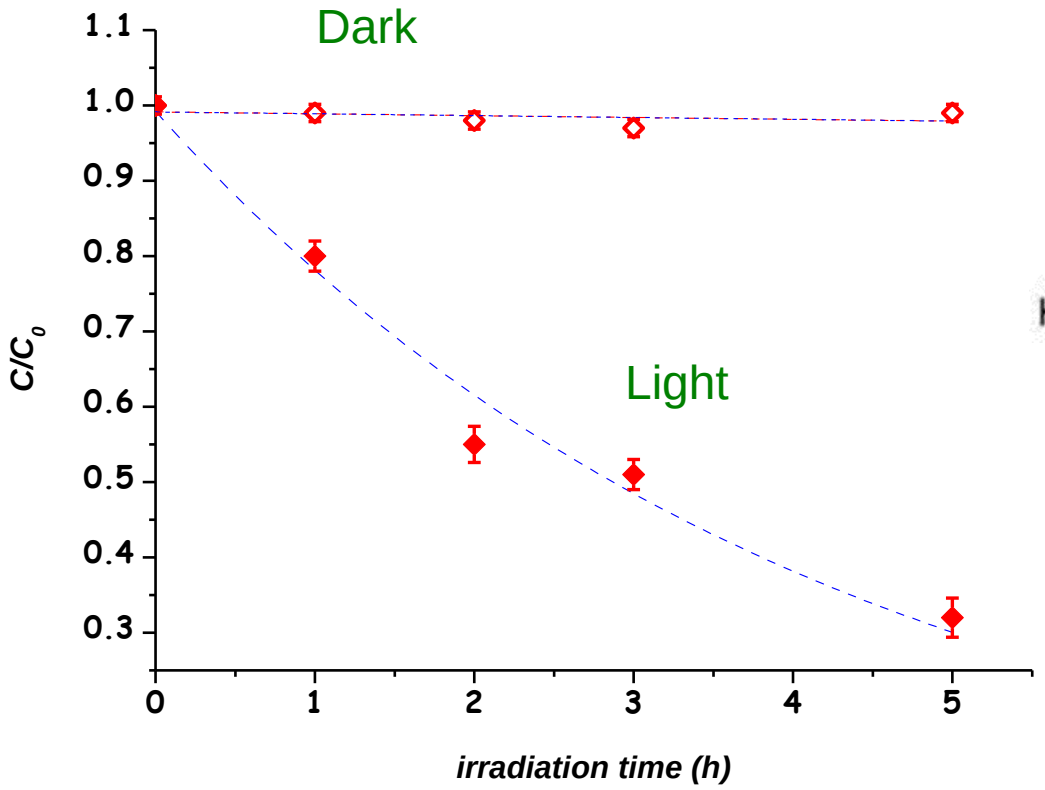
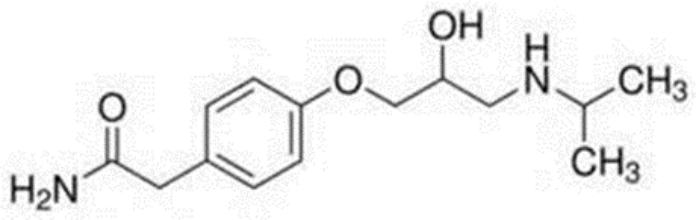
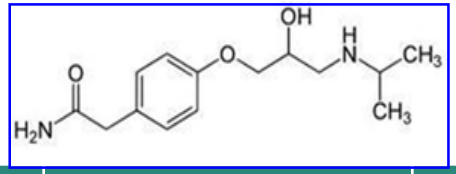
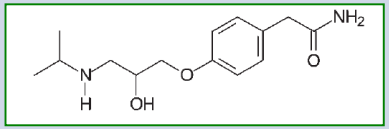
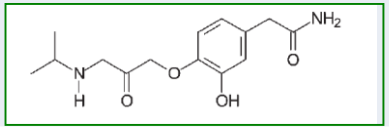
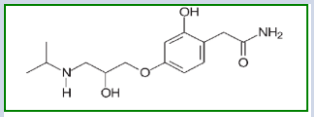
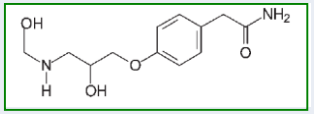
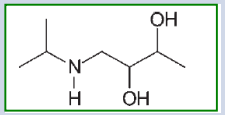
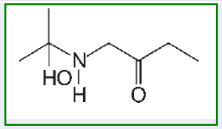
Fotodegradazione dell'Atenololo



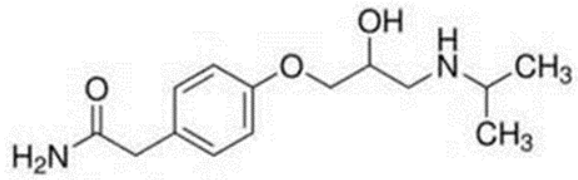


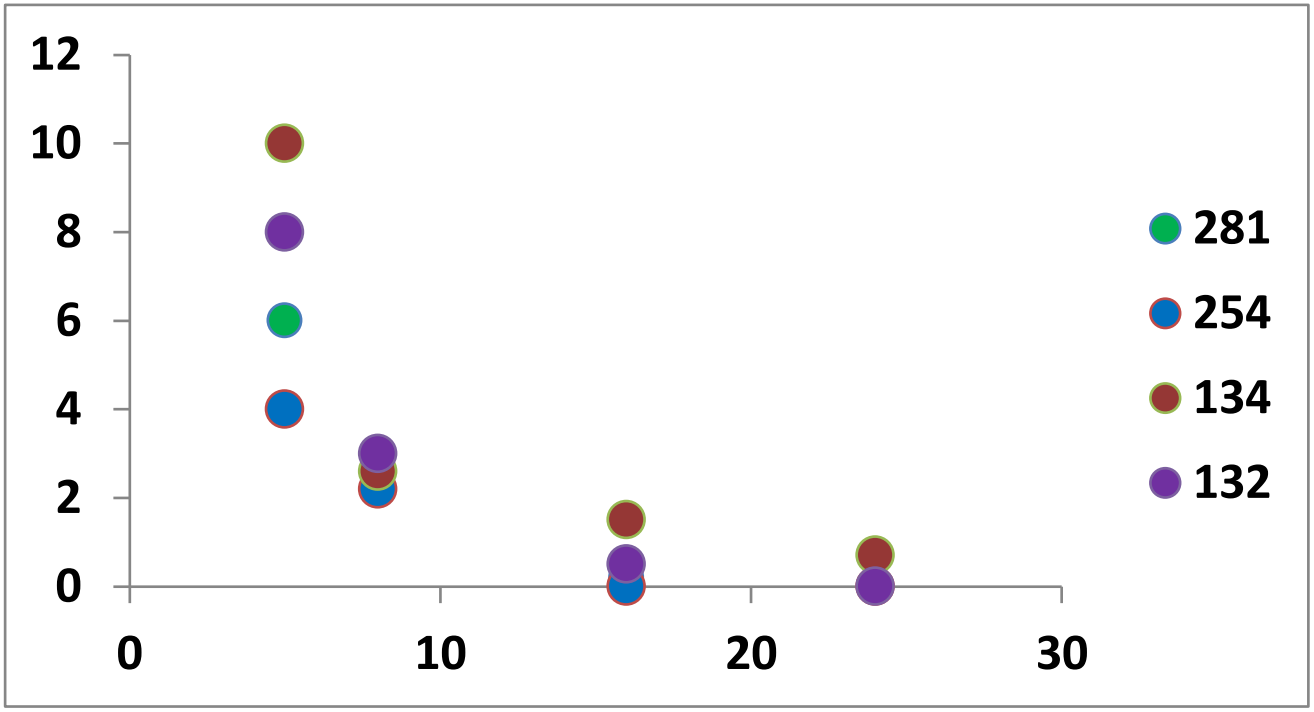
Intermedi di Fotodegradazione dell'Atenololo

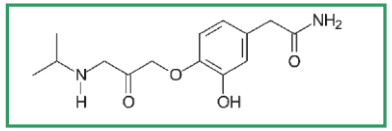


Precursor ion	tr (min)	MS^2	Structure
267.17	6.87	225.07 190.01 208.06	
281.15	8.39	116.19 121.08	
299.16	14.19 15.27	253.04	
254	12.5	236.20 245.15	
134	2.26	116.10	
132	1.98 2.23	86.06	

Fotodegradazione Intermedi dell'Atenololo







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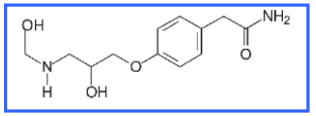

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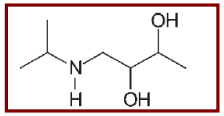

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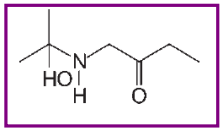

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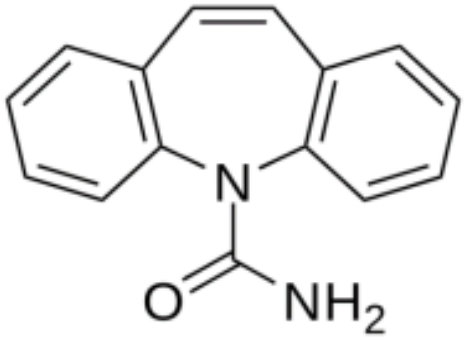
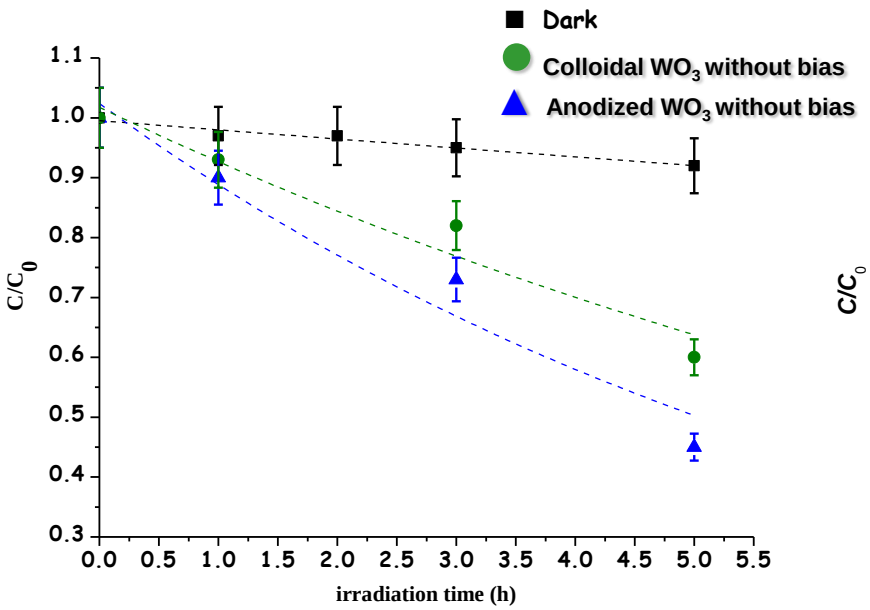
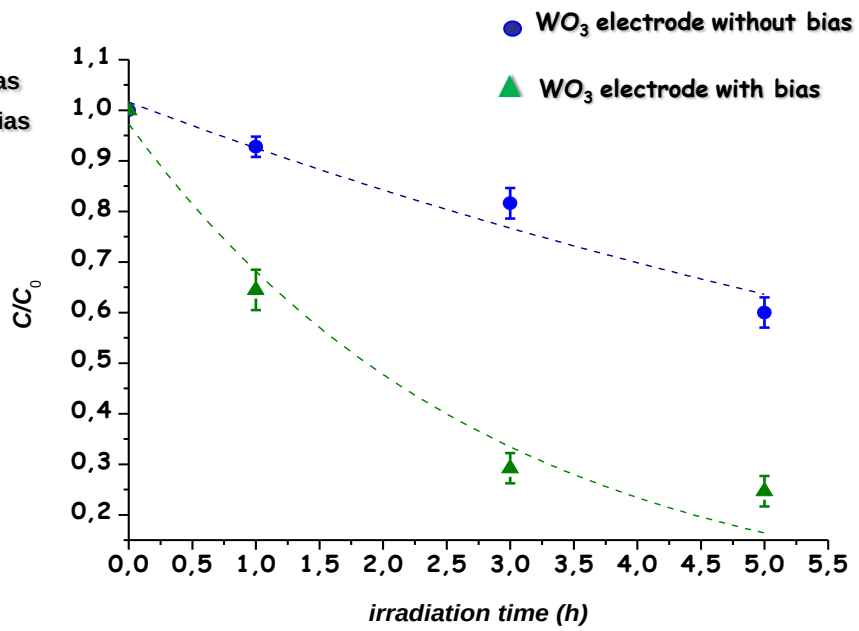
Fotodegradazione Carbamazepina



Fotodegradazione

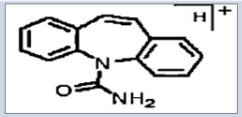
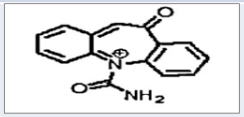
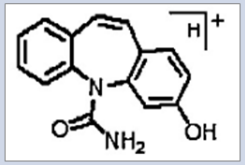
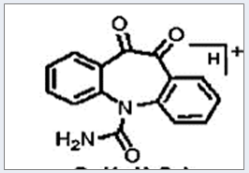
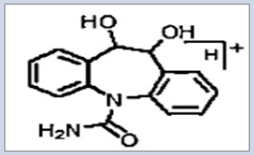


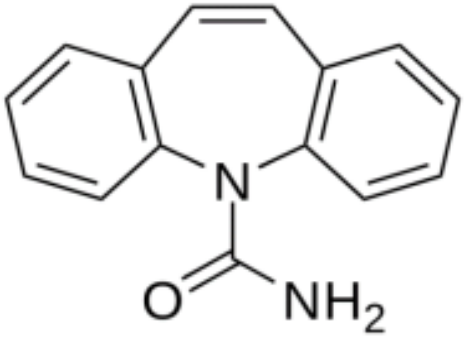
Fotoelettro-degradazione



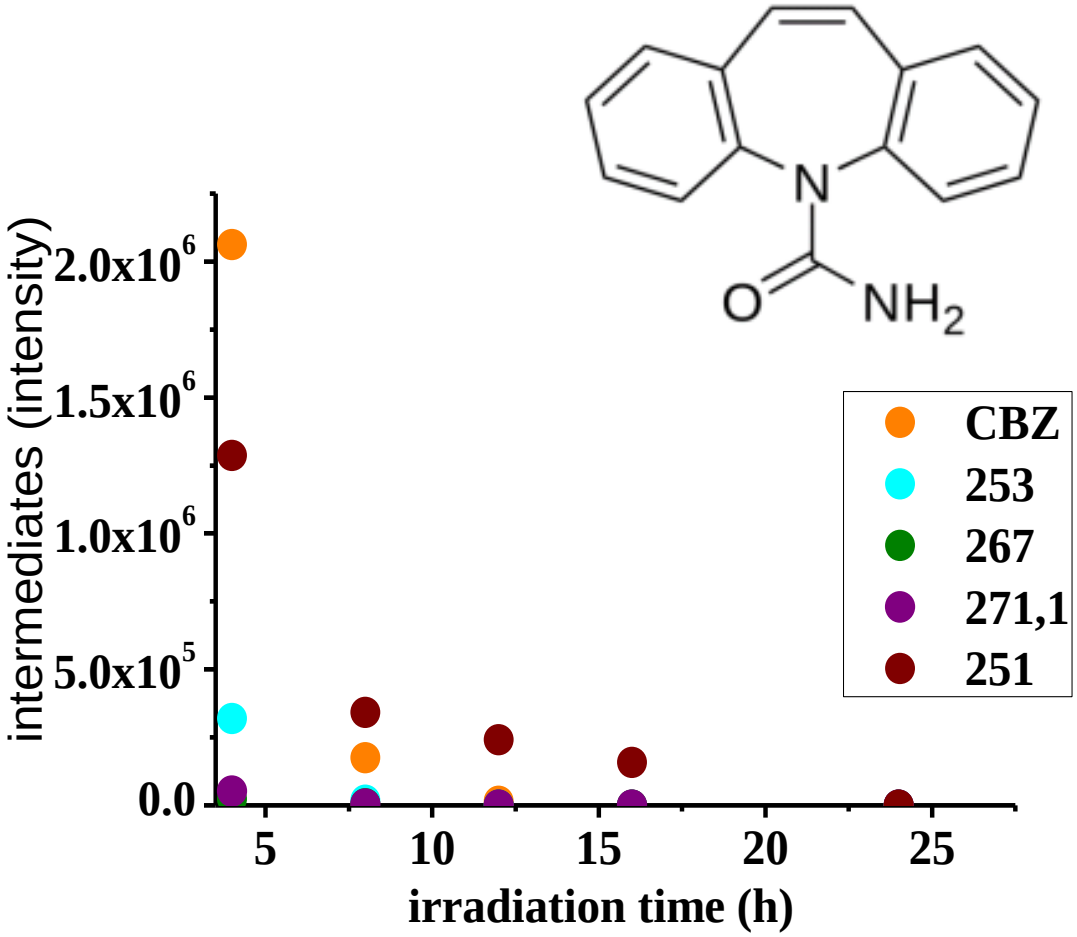
Intermedi di Fotodegradazione della Carbamazepina

Intermedi di degradazione

Precursor ion	tr (min)	MS^2	Structure
237.1	14.35	194.01 220.06	
251.1	14.5	180.1 208.1 223.1	
253.1	12.3	208.0 210.0 236.0	
267.1	16.2	168.0 196.1 211.1	
271.1	9.6	210.0 253.0	



Fotodegradazione Intermedi della Carbamazepina



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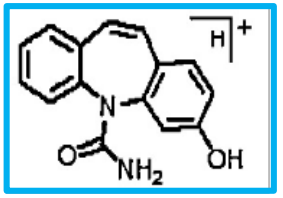

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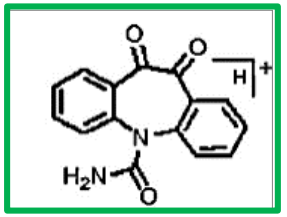

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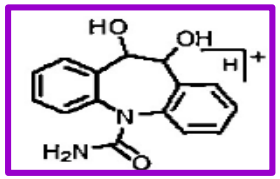

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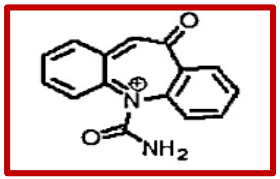

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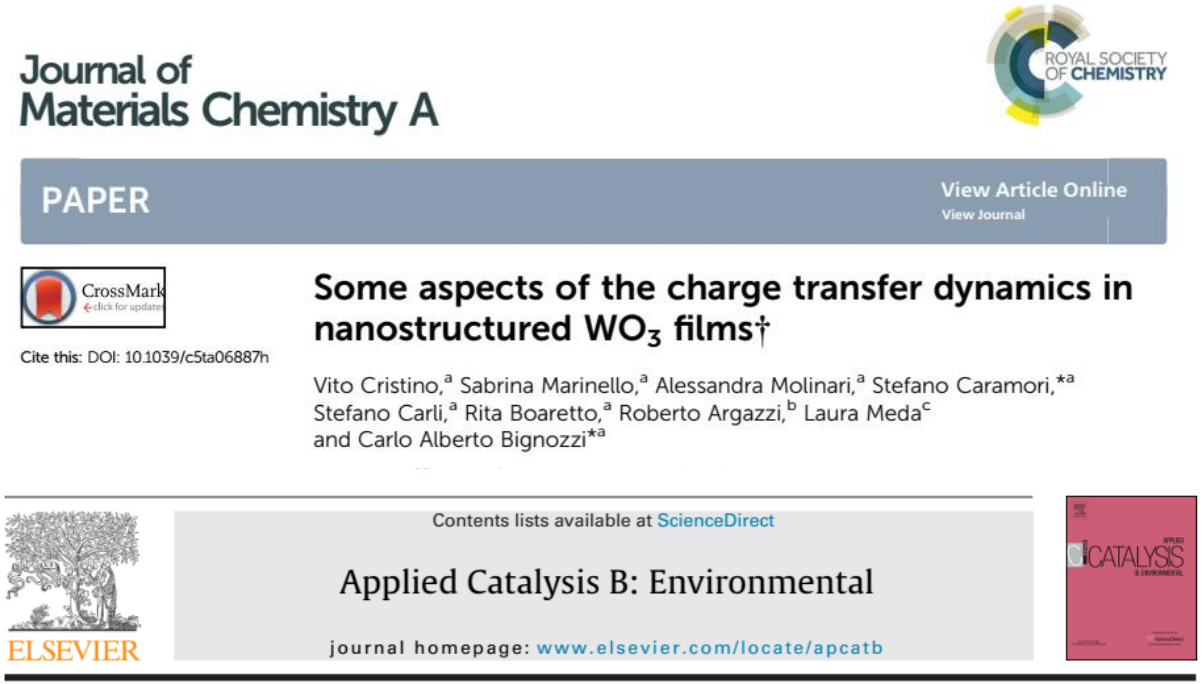
Letteratura di Riferimento



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Some aspects of the charge transfer dynamics in nanostructured WO_3 films†

Vito Cristino,[a] Sabrina Marinello,[a] Alessandra Molinari,[a] Stefano Caramori,*[a] Stefano Carli,[a] Rita Boaretto,[a] Roberto Argazzi,[b] Laura Meda[c] and Carlo Alberto Bignozzi*[a]

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Photoelectrochemical mineralization of emerging contaminants at porous WO_3 interfaces

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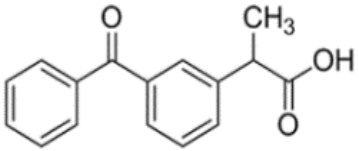
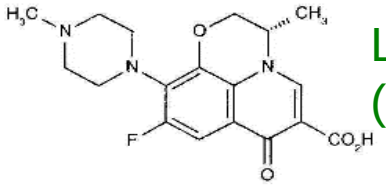
Degradazione del Ketoprofene e Levofloxacina

Ketoprofene (KTP)





Levofloxacina (LEVO)

Fotodegradazione

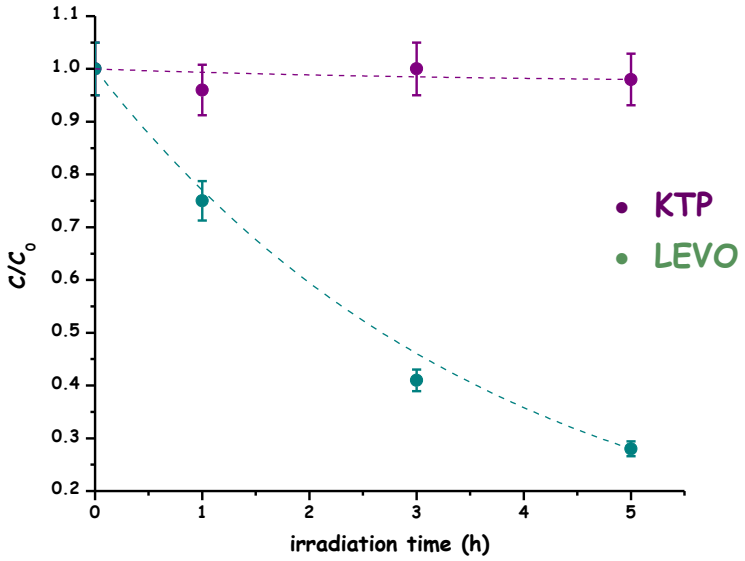
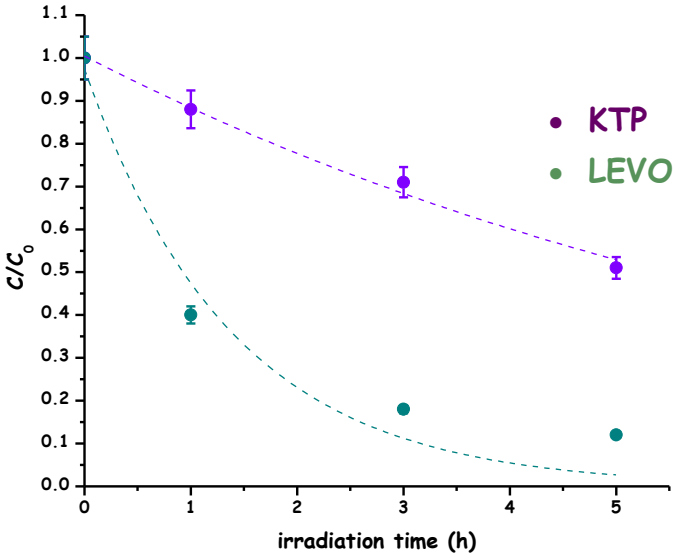


Foto-elettro-degradazione



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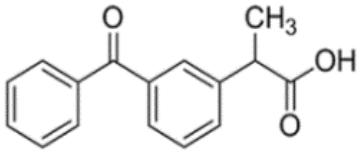
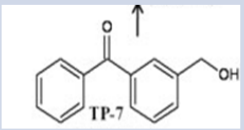
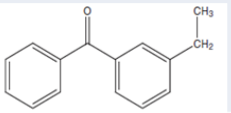
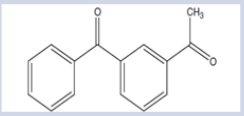
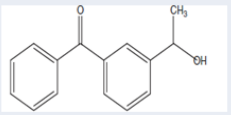
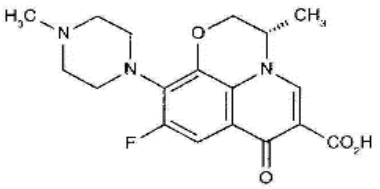
Intermedi
Ketoprofene e Levofloxacina

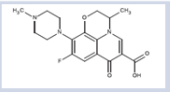
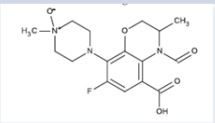
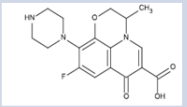
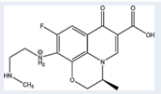
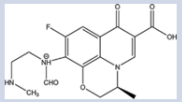
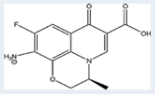
KTP



Precursor ion	tr	MS^2	Structure
211	17.17	196 182 183 154	
211	14.35	105	
225	15.48	183 147 105	
227	13.59	76 105 209	

LEVO



Precursor ion	tr	MS^2	Structure
361	7.18	362 318	
337	4.48	320 310 294 292	
347	7.10	304 284 261	
335	6.96	261 235	
363	6.51	346 333 289 261 235	
278	9.79	261	

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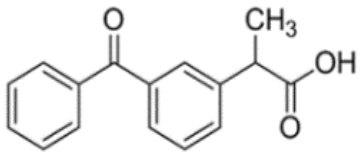
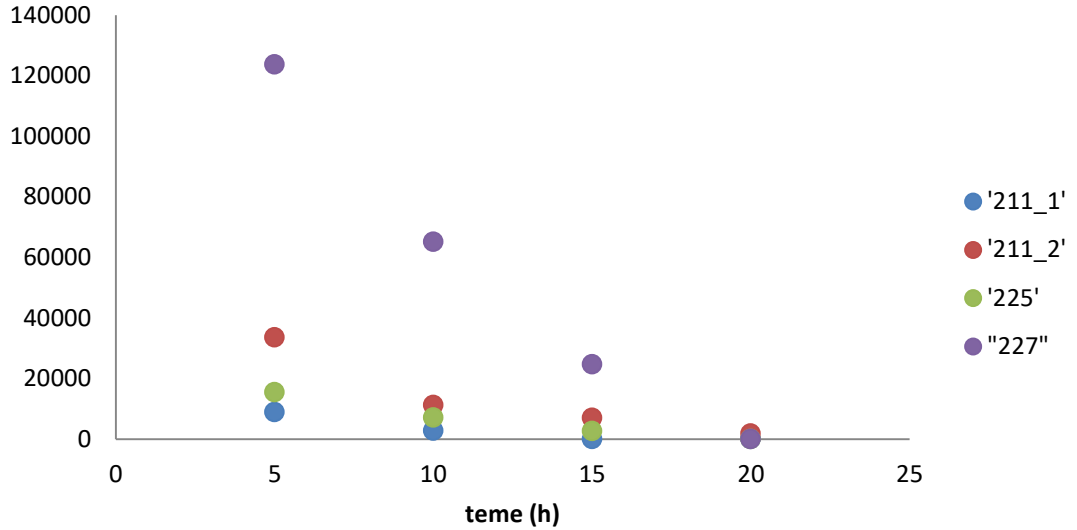
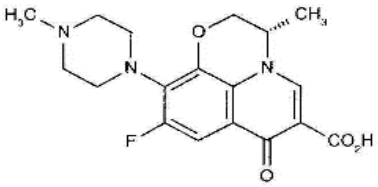
Fotodegradazione Intermedi Ketoprofene e Levofloxacina

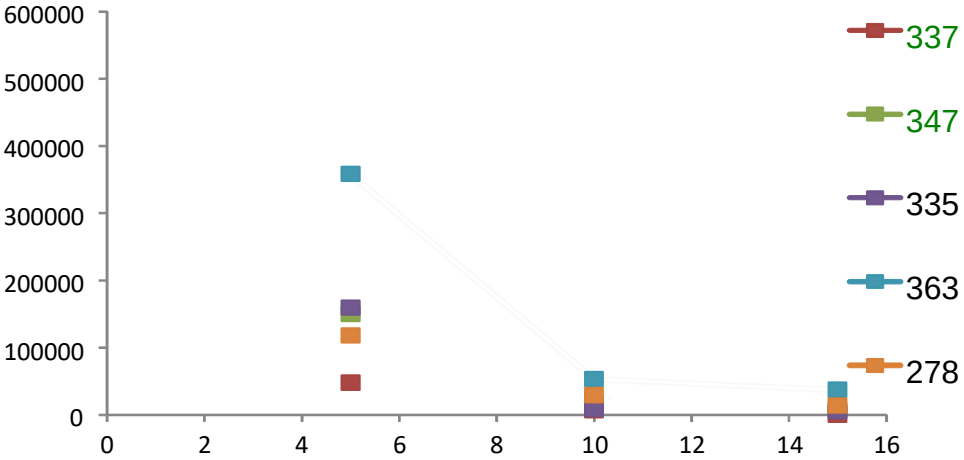
KTP





LEVO





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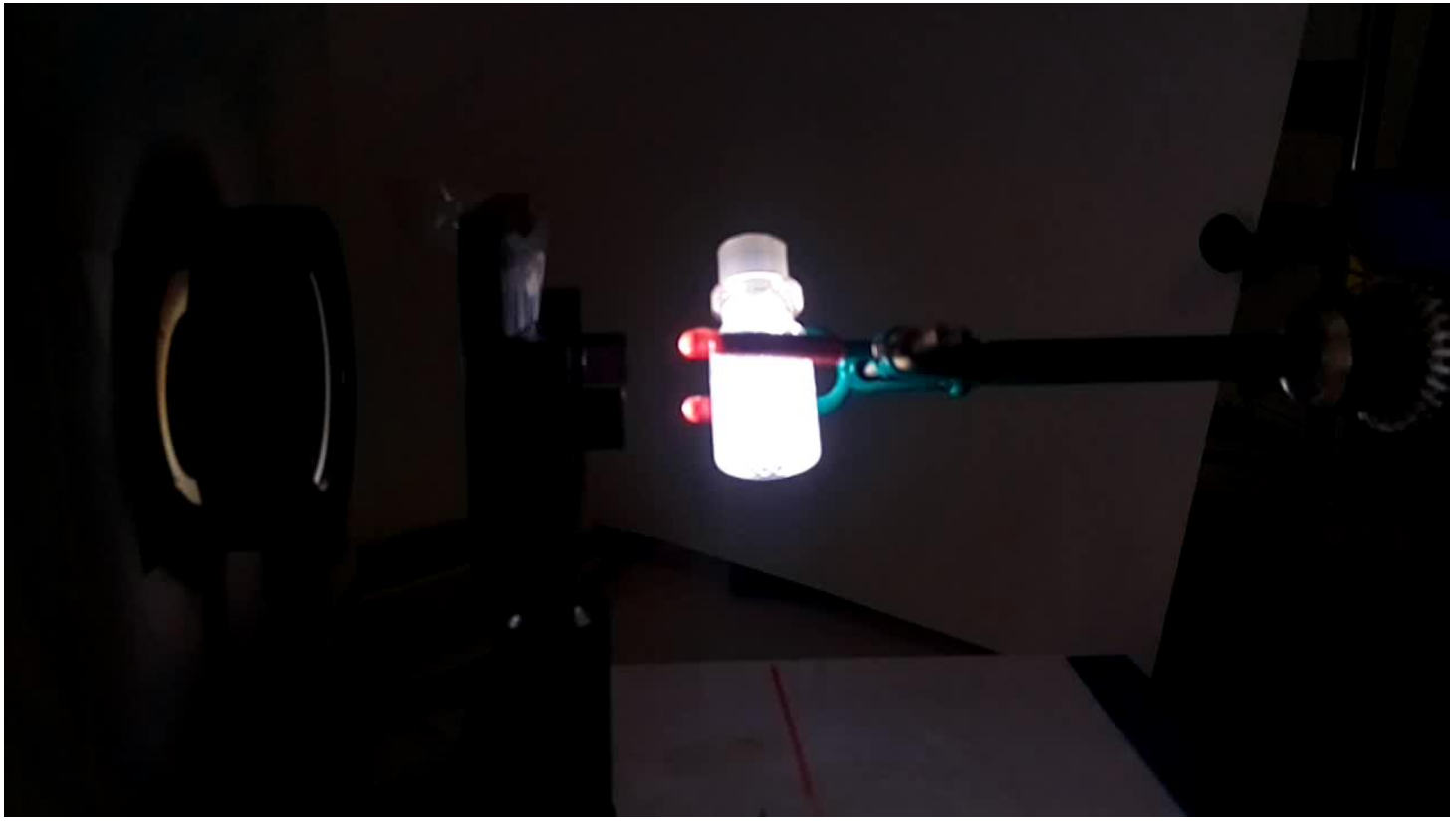
Potabilizzazione delle acque
Batteri e microrganismi

Alcuni dei microrganismi che possono essere presenti nelle acque superficiali

Batterio	Malattia/ infezione	Sintomi
Aeromona	Enteriti	Diarrea, contenente sangue e muco
Campilobacter jejuni	Campilobacteriose	Influenza, diarrea, dolore di testa o di stomaco, febbre, crampi, nausea
Escherichia coli	Infezione del tratto urinario, maningiti neonetali, disturbi intestinali	Diarrea, mal di testa, febbre, danneggiamento dei reni
Plesiomona shigelloide	Infezione da plesiomona	Nausea, mal di stomaco e diarrea, talvolta febbre, mal di testa e vomito
Salmonella	Febbri da tifo	Febbre
	Salmonellosi	Malessere, crampi intestinali, vomito, diarrea e qualche volta leggera febbre
Streptococco	Disturbi (Gastro) intestinali	Mal di stomaco, diarrea e febbre, talvolta vomito

Fonte: Lenntech BV

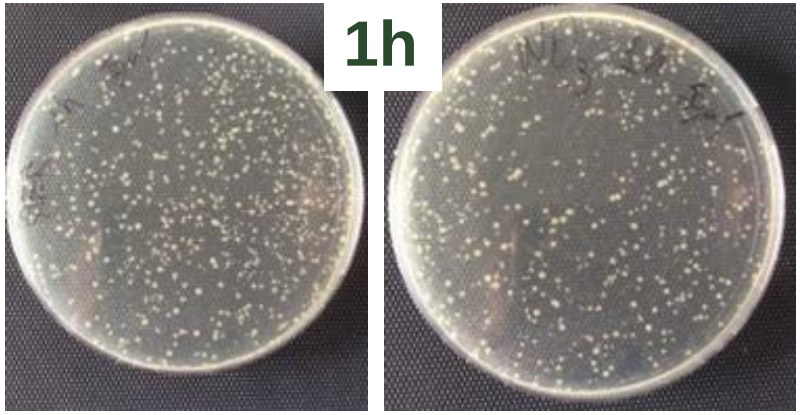
Attività antimicrobica WO_3



Attività antimicrobica

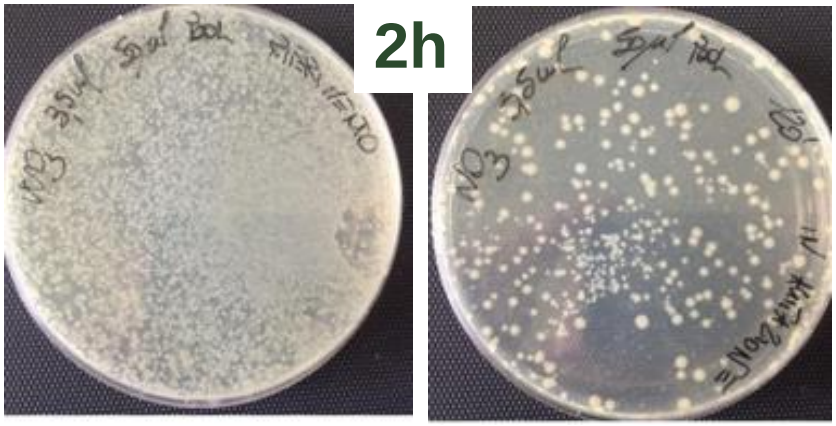
Controllo WO_3

1h



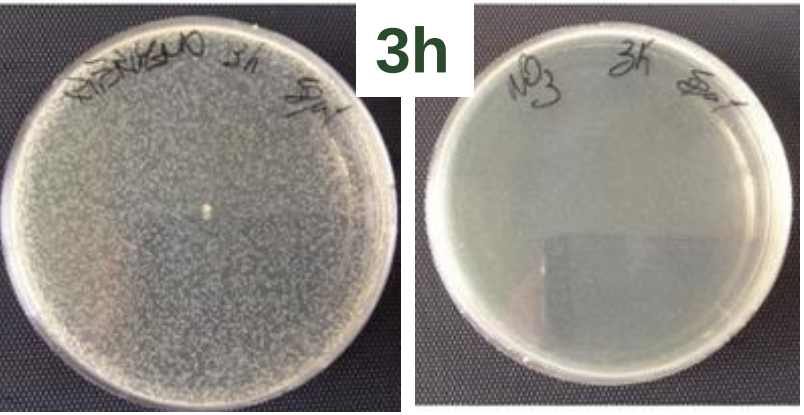
Controllo WO_3

2h



Controllo WO_3

3h



Pool Microbico

1-5x10^{10} ufc/ml

Pseudomonas aeruginosa, ATCC 15442 ;
Staphylococcus aureus, ATCC 6538 ;
Escherichia coli, ATCC 10536;
Enterococcus hirae, ATCC 10541;
Candida albicans, ATCC 10231.

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Contatti
Referenti del Progetto

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RINGRAZIAMENTI

POR FESR EMILIA-ROMAGNA 2014/2020

RegioneEmilia-Romagna