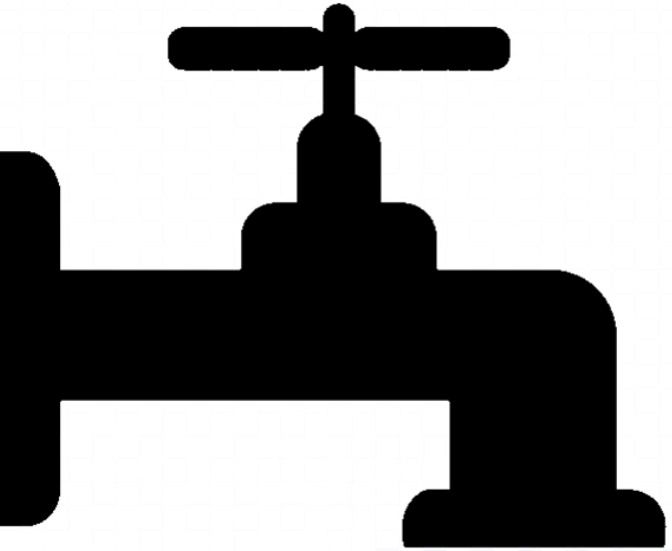
NanoCatRed and SmartOxidation projects towards reduction and oxidation of pollutants in water

Olívia Salomé G.P. Soares

salome.soares@fe.up.pt

PROBLEMATIC



Organic micropollutants

- *Pesticides*
- *Fertilizers*
- *Pharmaceuticals*
- *(..)*

Inorganic pollutants

- *Heavy metals*
- *Nitrate, bromate, perchlorate, fluoride, (…) ions*

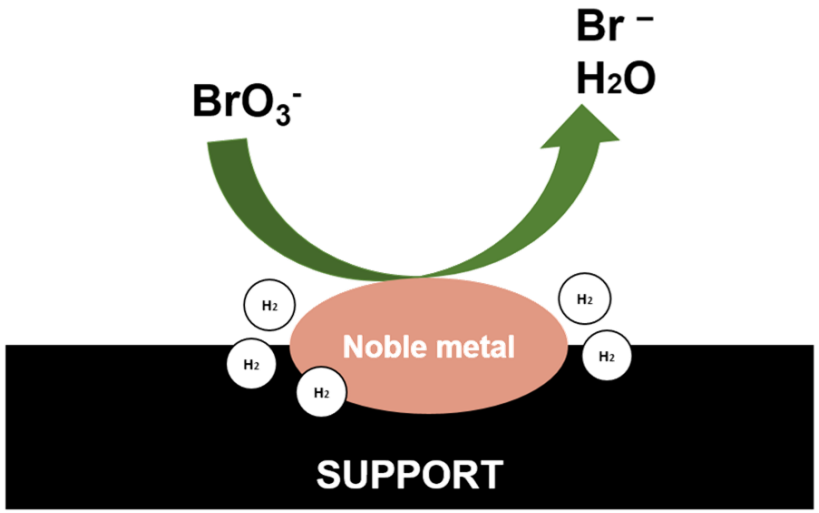
HETEROGENEOUS CATALYTIC PROCESSES

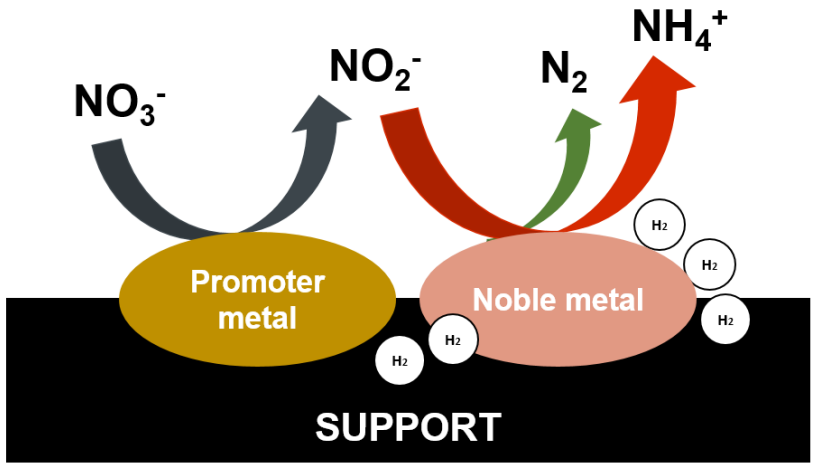
→ Degradation/conversion into less toxic species

→ Organic and inorganic species removal

SOLUTION: Inorganic pollutants

CATALYTIC REDUCTION





NanoCatRed

Novel metallic NANOparticles on NANOstructured supports for oxyanion CATalytic REDuction in water

Main Goal: Development of nanostructured catalytic systems capable of achieving the efficient removal of a range of inorganic pollutants in application to real cases.

Research Team @ FEUP

Salomé Soares Fernando Pereira Carla Orge João Restivo Sofia Santos José Barbosa

Partners

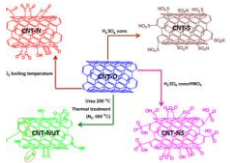
Development of advanced water treatment systems

adventech® advanced environmental technologies

Modification of nanostructured supports and catalytic testing

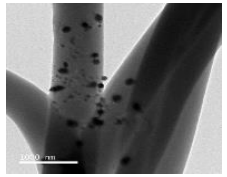
U.PORTO

FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

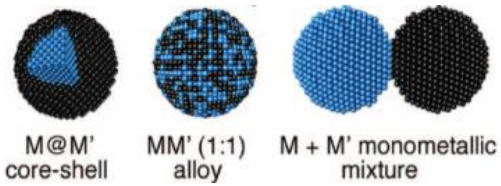


Advanced synthesis and characterization techniques

INL



Novel metallic nanoparticles preparation



Cofinanciado por:

FCT Fundação para a Ciência e a Tecnologia

UTAustin Portugal

COMPETE 2020

PORTUGAL 2020

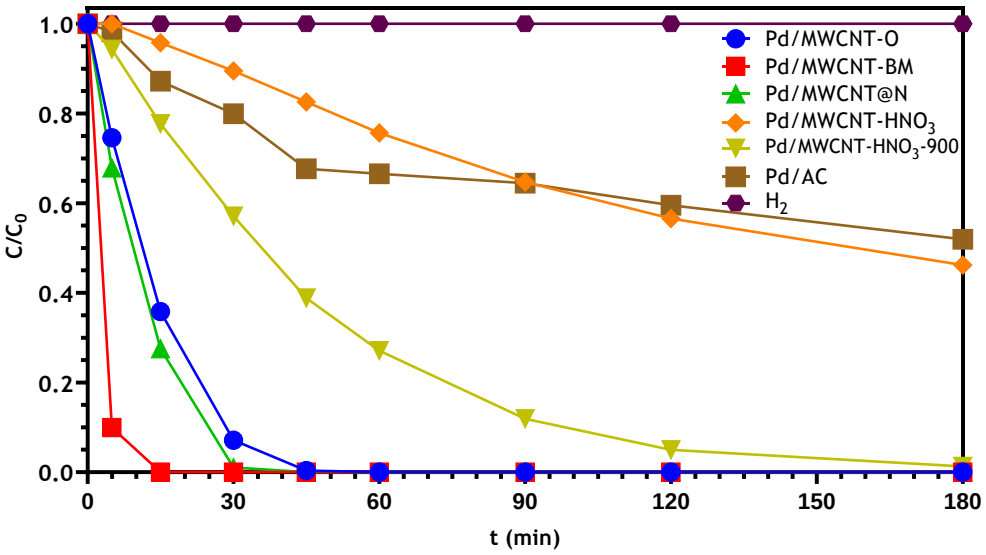
UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional

NORTE2020 PROGRAMA OPERACIONAL REGIONAL DO NORTE

RESULTS

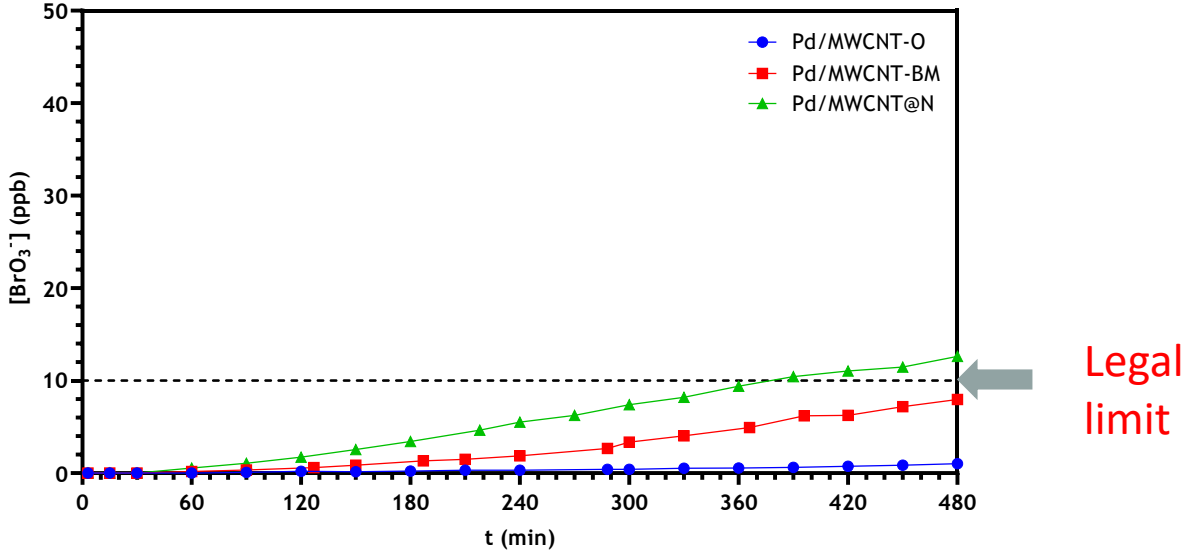
Batch reactor
screening of catalyst support for bromate reduction:

C_0 = 200 ppb
H_2 = 50 cm^3 min^{-1}
0.125 g_{CAT} L^{-1}



Continuous reactor
assessment of ability to remove bromate under 10 ppb guideline:

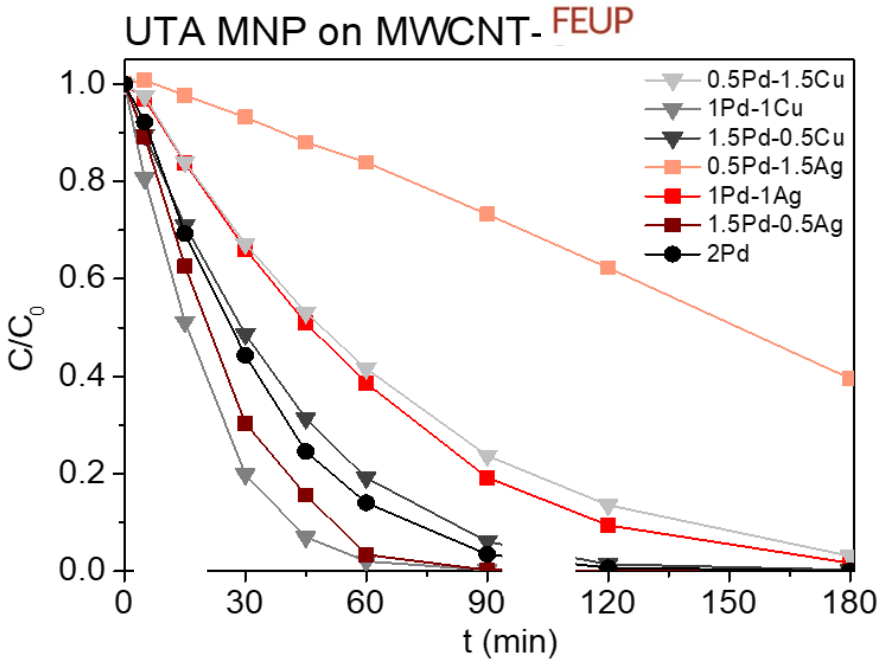
C_0 = 200 ppb
Q = 5 mL min^{-1}
H_2 = 12.5 cm^3 min^{-1}
0.200 g_{CAT}



RESULTS

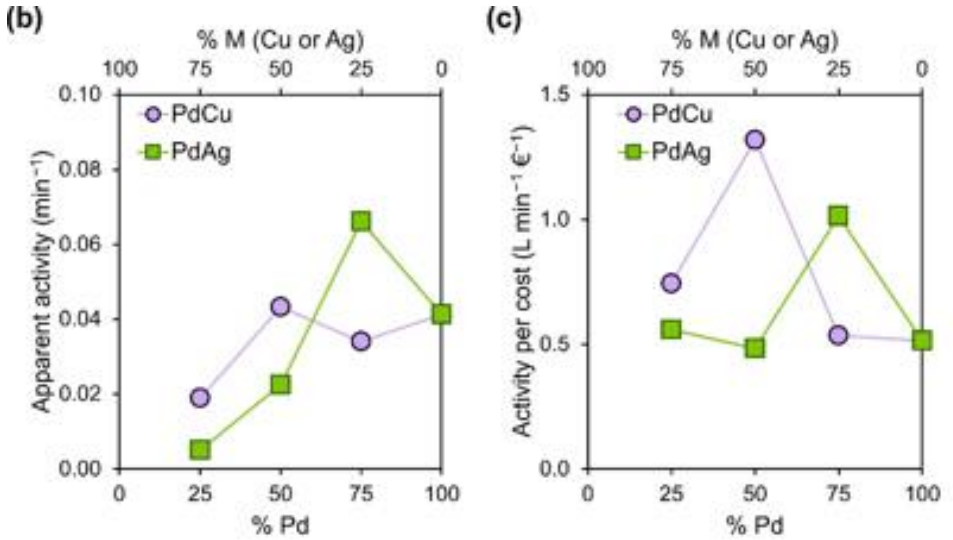
Bimetallic nanoparticles

palladium/silver and palladium/copper supported on MWCNT-O:



Formation of noble metal – transition metal particles can reduce the cost of the metallic phase while improving its performance due to the tuning of the hydrogen bonding energies on the catalyst surface

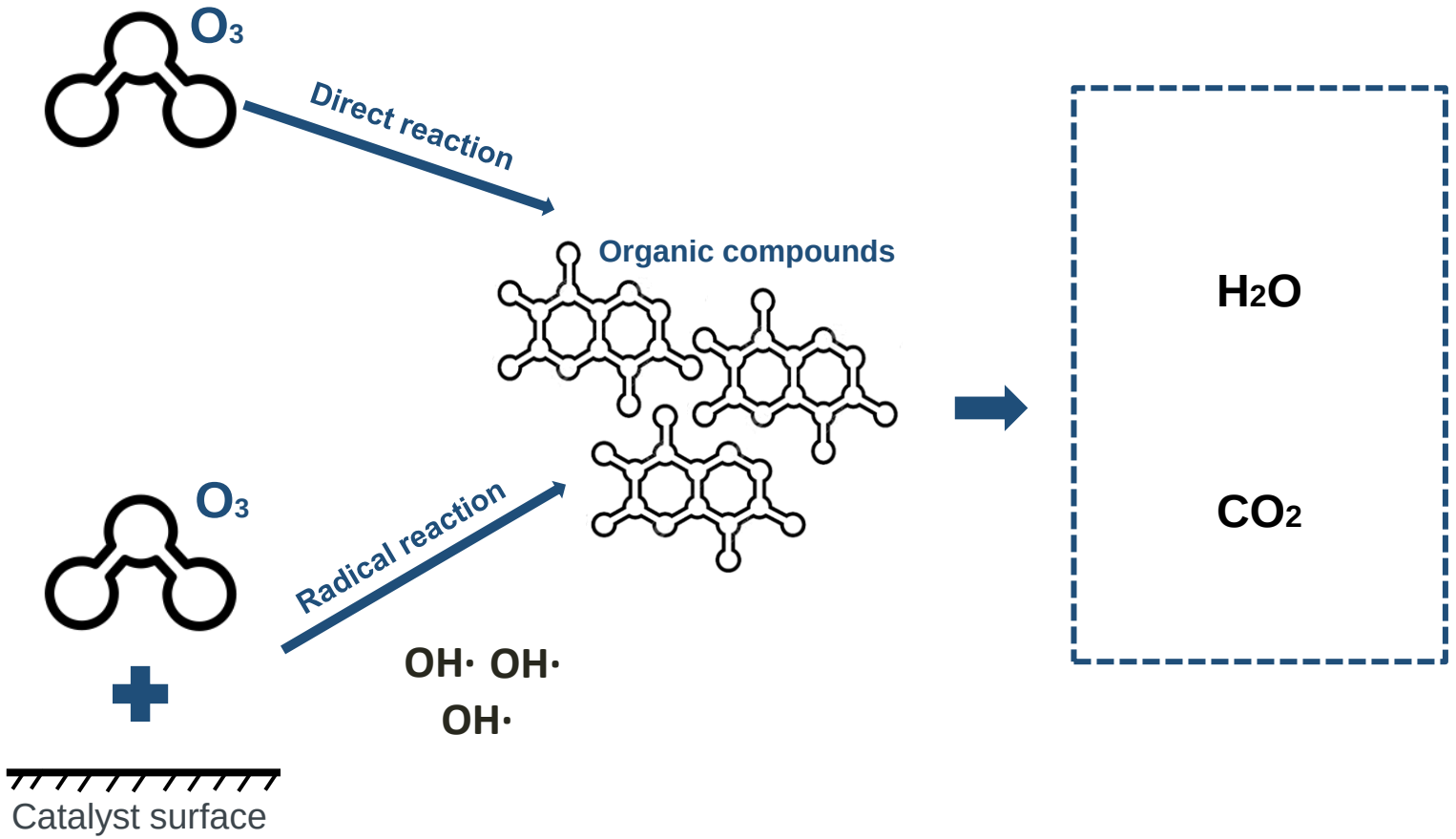
Activity as a function of composition



- an optimal composition of Pd-Cu and Pd-Ag catalysts was found, both performing better than the noble metal Pd catalyst;
- when the cost of the metallic phase is considered, the potential of the noble metal – transition metal catalysts is evident

SOLUTION: Organic micropollutants

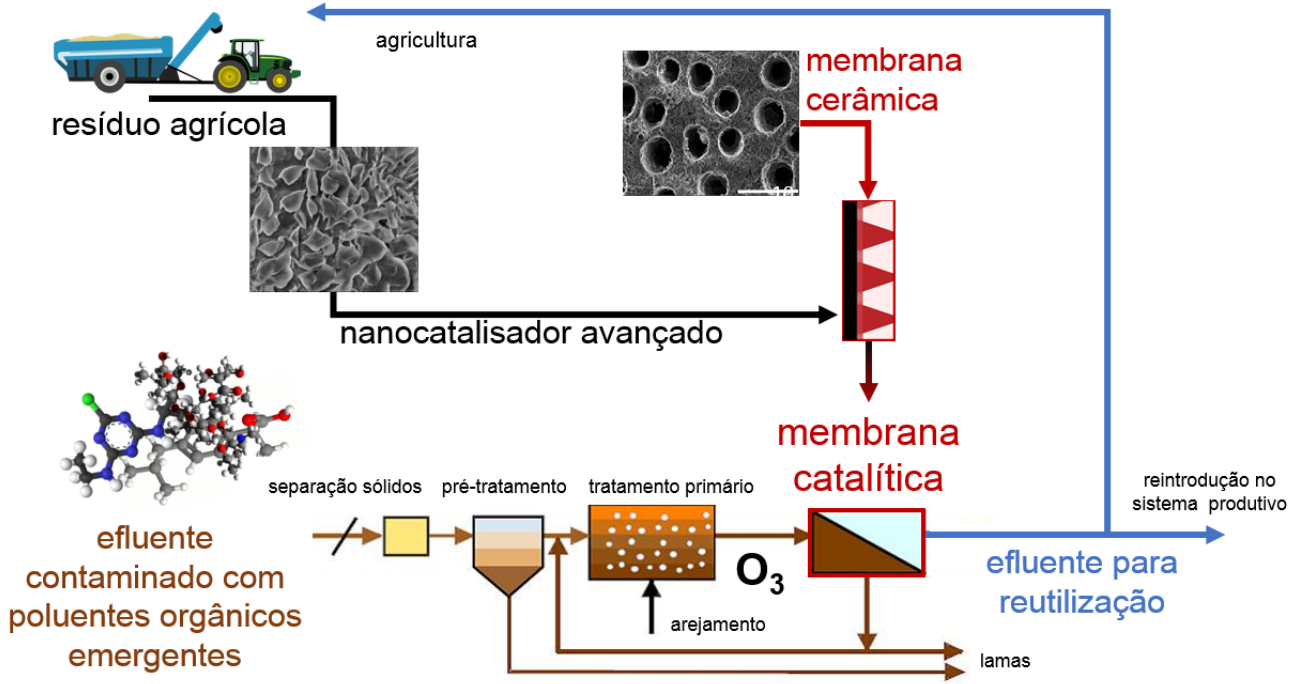
CATALYTIC OZONATION



Smart Oxidation

Functional membranes for oxidation of emerging pollutants in wastewater

Main Goal: To develop an efficient technology for the removal of organic micropollutants from the effluents produced in wastewater treatment plants, aiming at their reuse.



Research Team @ FEUP

Salomé Soares | Fernando Pereira | Carla Orge | Cátia Graça | João Restivo | Adrián Silva

Partners

Smart Separations Portugal

U.PORTO FEUP Faculdade de Engenharia Universidade do Porto

SRE CM Laboratory of Separation and Reaction Engineering Laboratory of Catalysis and Materials

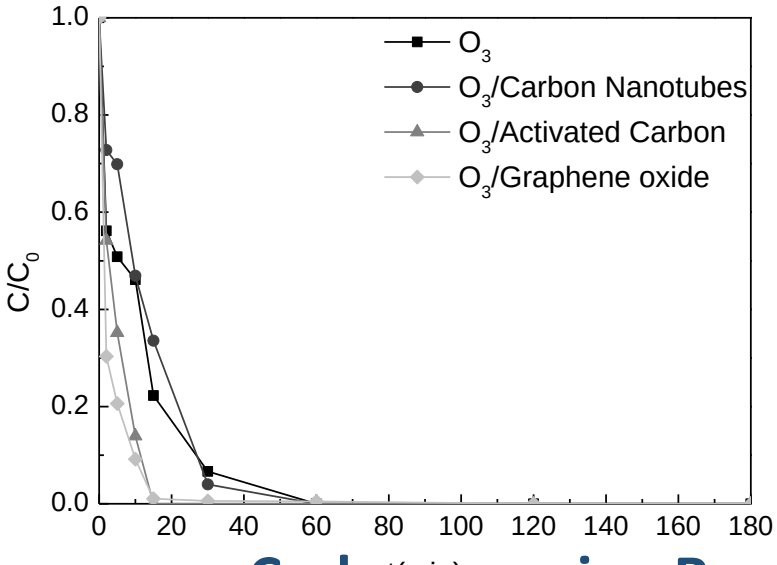
INL International Iberian Nanotechnology Laboratory

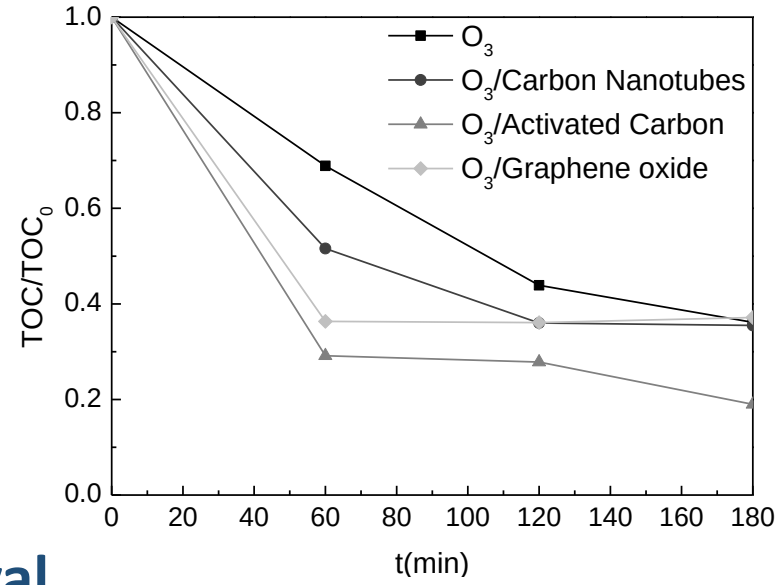
Águas do Centro Litoral — Grupo Águas de Portugal

Portugal 2020 | União Europeia — Fundos Europeus Estruturais e de Investimento

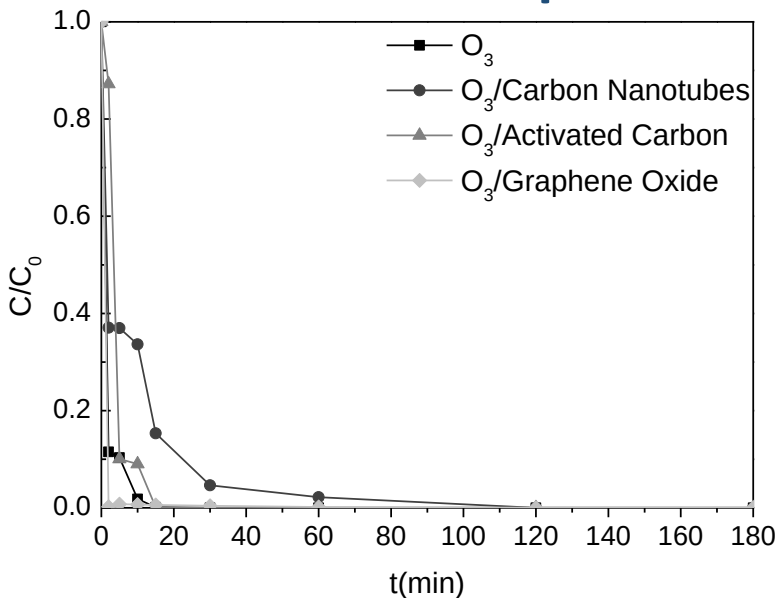
RESULTS

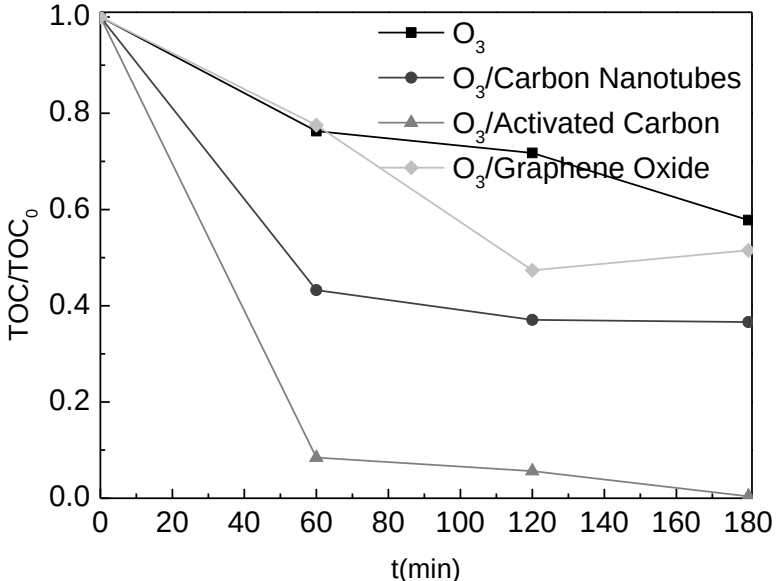
Salicylic Acid Removal





Carbamazepine Removal

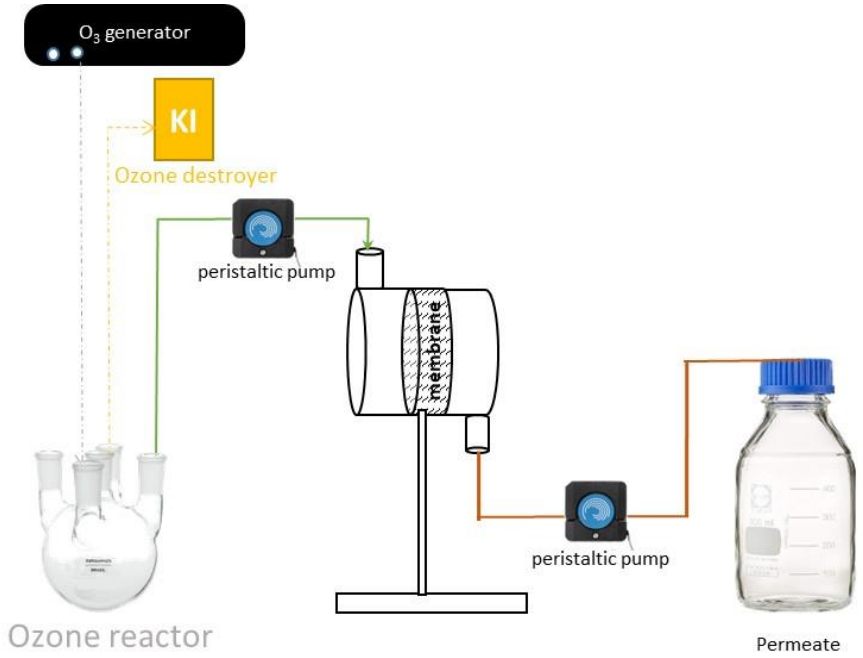




Screening of pristine and modified carbon materials led to a set of promising catalysts for membrane impregnation

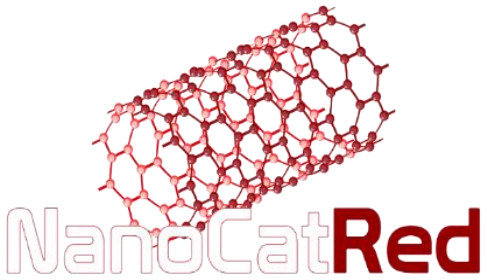
RESULTS

Experimental set-up ready for testing catalytic membranes in continuous operation mode



Different types of membranes are being tested for their ozone resistance and suitability for impregnation;

FINAL REMARKS



Achievement of:

- efficient reduction of the oxyanions in a custom-built lab-scale pilot installation (100—1000 L/h)
- at environmentally relevant concentrations (bromate: 0.01 mg/L, nitrate: 50 mg/L, nitrite: 0.1 mg/L, ammonium: 0.5 mg/L; perchlorate: 0.0245 mg/L)
- with less than 5% loss of activity in long-term testing (>100h)

Smart Oxidation

- Scale-up of the membrane catalytic ozonation reactor
- Test on a L/h scale using water collected in WWTPs
- Obtaining treated effluent with adequate quality for its reuse using flows representative of the systems of the industrial partner ACL

Acknowledgements

This research was financially supported by national funds (PIDDAC) through FCT/MCTES and by NanoCatRed (NORTE-01-0247-FEDER-045925) and SmartOxidation (NORTE-01-0247-FEDER-069836) co-financed by the ERDF – European Regional Development Fund through the Operation Program for Competitiveness and Internationalization – COMPETE 2020, the North Portugal Regional Operational Program – NORTE 2020 and by the Portuguese Foundation for Science and Technology – FCT under UT Austin Portugal; LA/P/0045/2020 (ALiCE), UIDB/50020/2020 and UIDP/50020/2020 (LSRE-LCM), funded by national funds through FCT/MCTES (PIDDAC). C.A.O. acknowledges FCT funding under DL57/2016 Transitory Norm Programme. O.S.G.P.S. acknowledges FCT funding under the Scientific Employment Stimulus - Institutional Call CEECINST/00049/2018.

NanoCatRed and SmartOxidation projects towards reduction and oxidation of pollutants in water

Olívia Salomé G.P. Soares

salome.soares@fe.up.pt