



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



Dipartimento di
Ingegneria Industriale

T.A.R.A.N.T.O. project: supported TiO_2 MOCVD thin films and doped TiO_2 powders for photocatalytic water remediation.

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**ENERGIE
PER
L'AMBIENTE
TARANTO**

Energy for **TARANTO**

Technology And pRocesses for the Abatement of pollutaNts and the remediation of conTaminated sites with raw materials recovery and production of energy tOtally green (TARANTO)

Proposal Code ARS01_00637

Consortium:

Project leader: **Consiglio Nazionale delle Ricerche – CNR**

CISA Spa (CISA) – Large Company

Biotec S.r.l. (BIOTEC) – SME

Astra Engineering S.r.l. (ASTRA) – SME

COMFORT ECO S.r.l. (COMFORTECO) - SME

Ecopan S.r.l. (ECOPAN) – SME

Socrate S.r.l. (SOCRATE) – SME

Omnitech S.r.l. (OMNITECH) – SME

Università degli Studi di Bologna (UNIBO)

Università degli Studi di Bari (UNIBA)

Duration: **30 months**

Starting date: **22 November 2018**

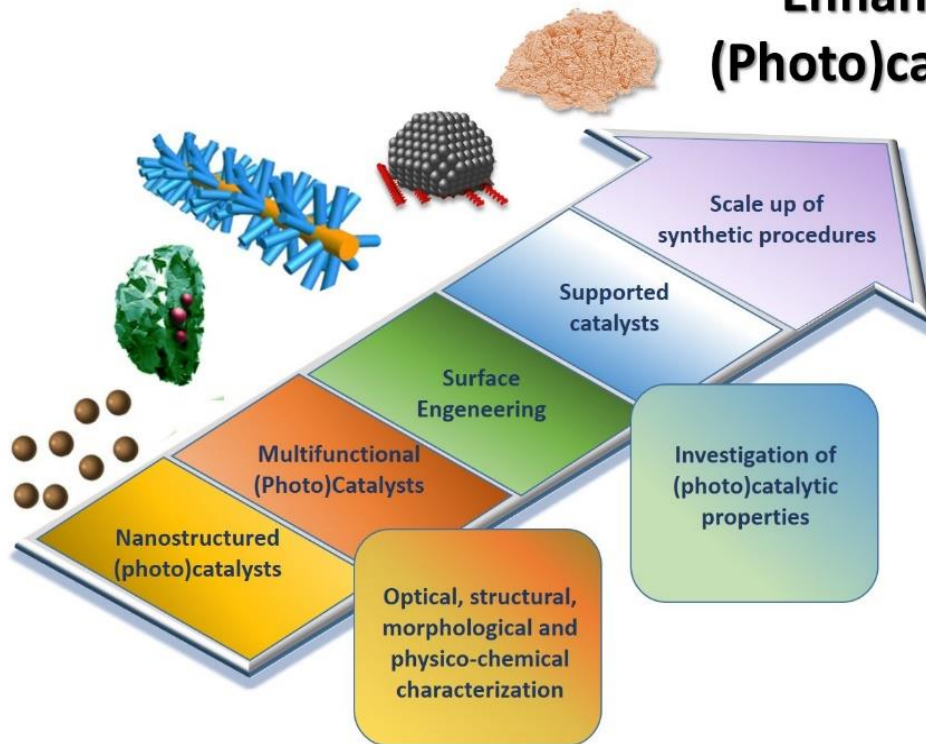
Closing date: **21 May 2021**

Technical and scientific objectives are:

- Water resource and energy recovery from wastewater treatment
- Materials and plants for purification of contaminated water
- Technologies of phyto-assisted bioremediation for contaminated soils
- Technologies for the production of biofuels from biomass resulting from bioremediation

OR2: “Design and realization of catalysts and photocatalysts and their integration into demonstrators”

Enhanced (Photo)catalysis

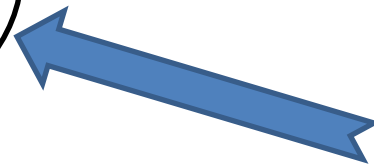
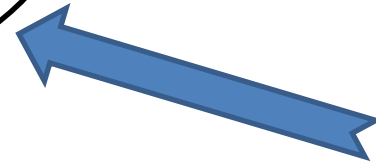


ICMATE is involved in:

- Development of chemical methodologies for the synthesis of crystalline nanoparticles (**by wet methods**) and as thin films (**by MOCVD**) with defined and programmable characteristics, mainly consisting of TiO_2 anatase, which can be activated by UV light.
- Laboratory scale assessment of photocatalytic performance.
- Immobilization of nanostructured photocatalysts.
- Physical-chemical characterization of the catalysts.

Synthesis of TiO_2 as
nano-micrometric
powder by wet-methods
and as thin film by
MOCVD.

Photocatalytic
performance evaluation
by internal protocols or
by ISO standards.



Nano- to micro-TiO₂ particles synthesis by wet method

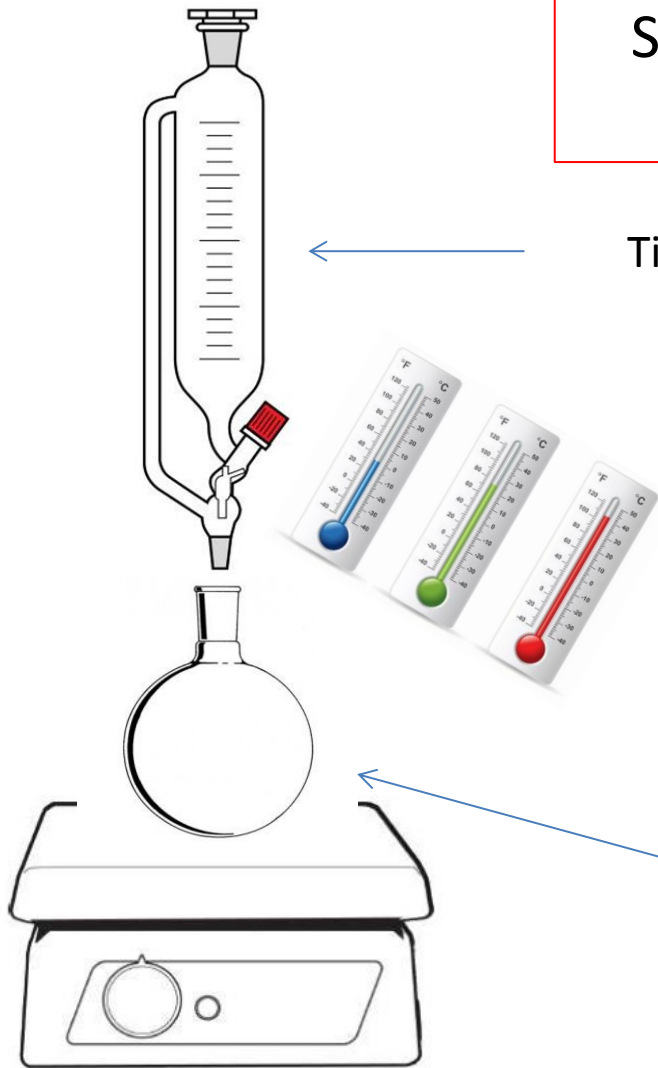
Synthesis of TiO₂ and TiO₂ doped with metals and/or non metals

Ti(OⁱPr)₄ (TTIP) in IPA as titanium precursor

Accurate temperature control!

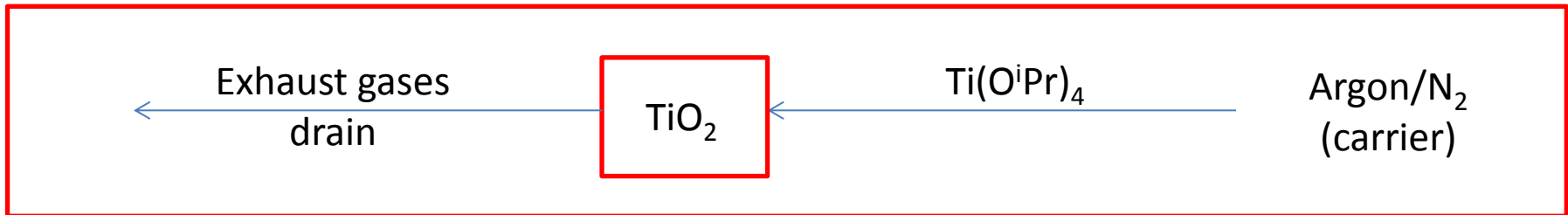
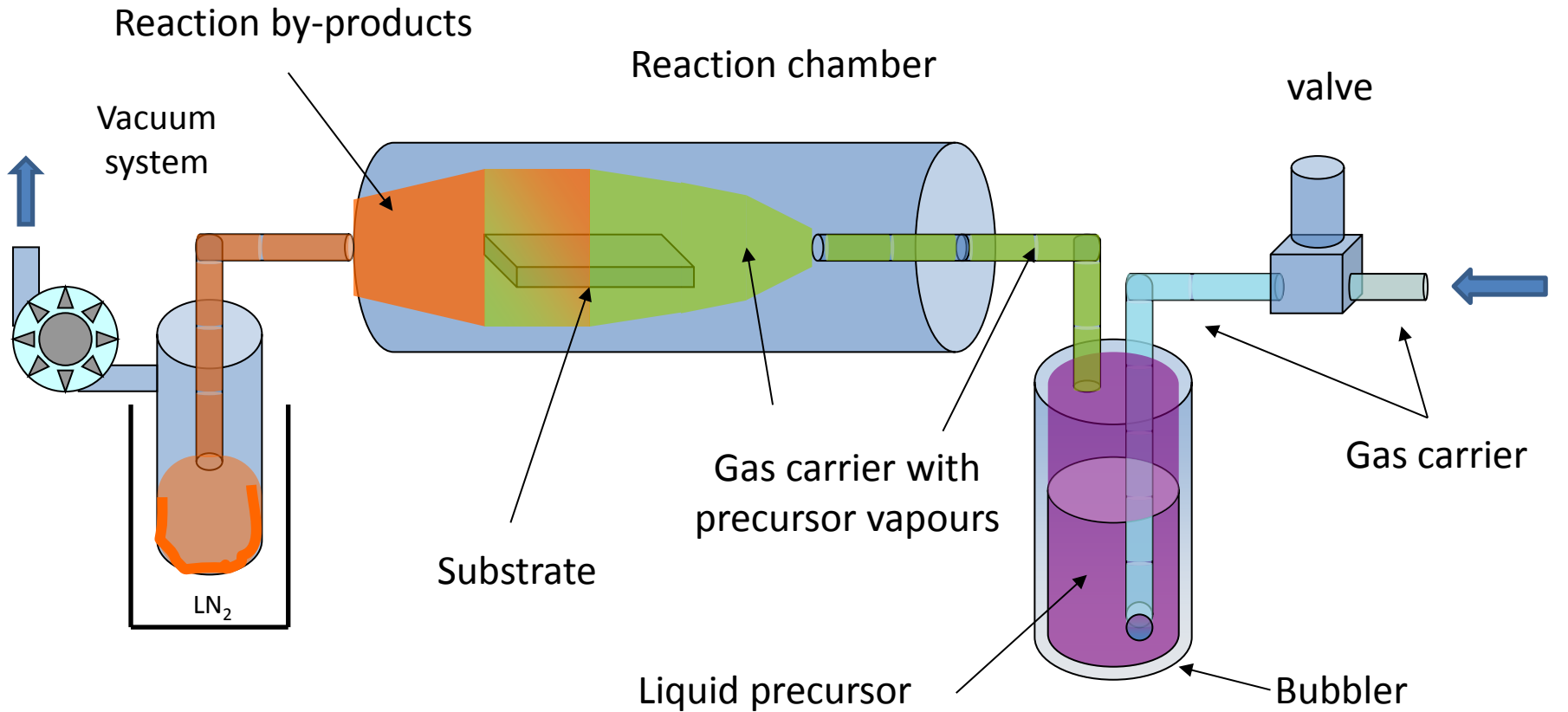
Temperature is a crucial parameter to guide the rutile-anatase relative amount

Water, acid and dopants (in case) in well defined amounts (with respect to TTIP)



After the solution ageing, solvent removal and thermal treatment are carried out

MOCVD reactor



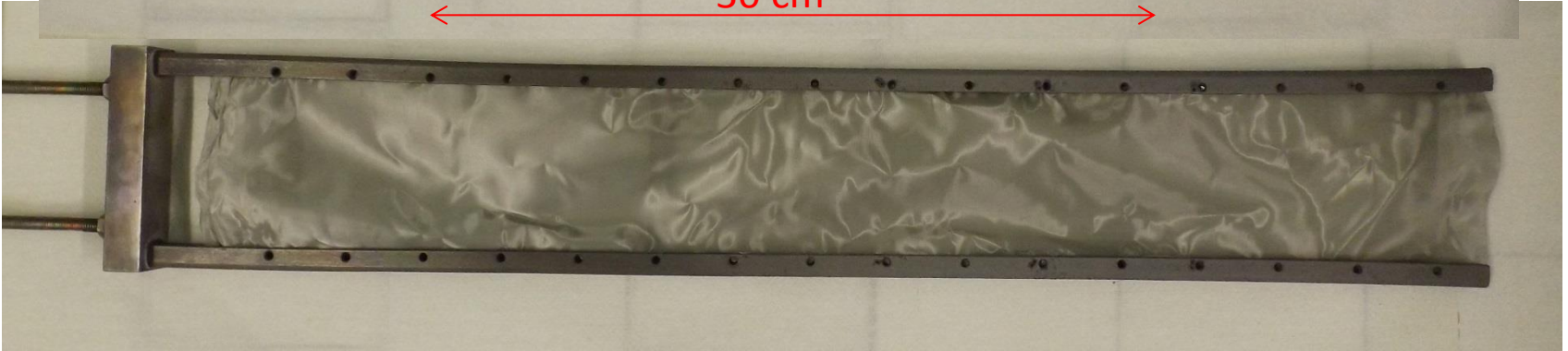
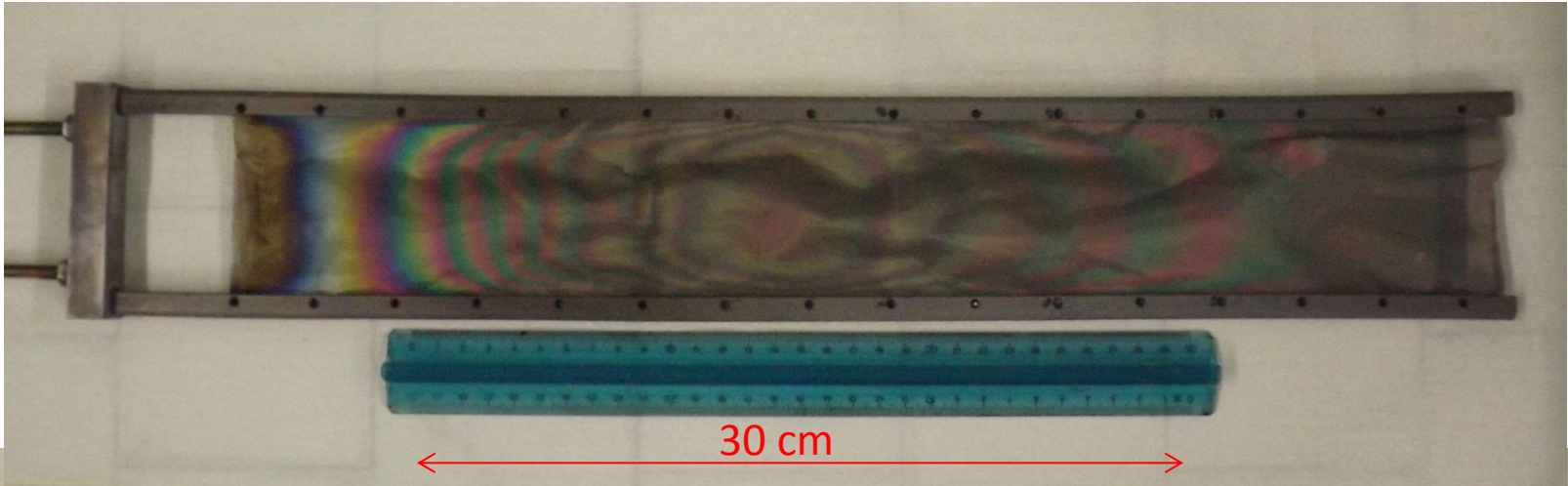


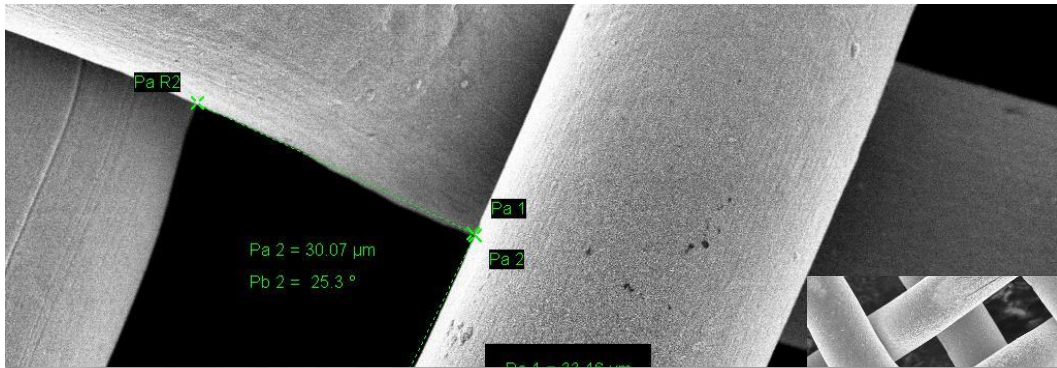
ALD
Atomic Layer Deposition
POSTER n°4
POSTER SECTION

MOCVD reactors

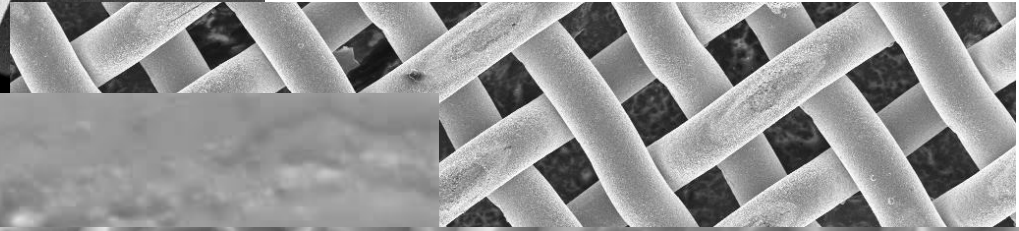




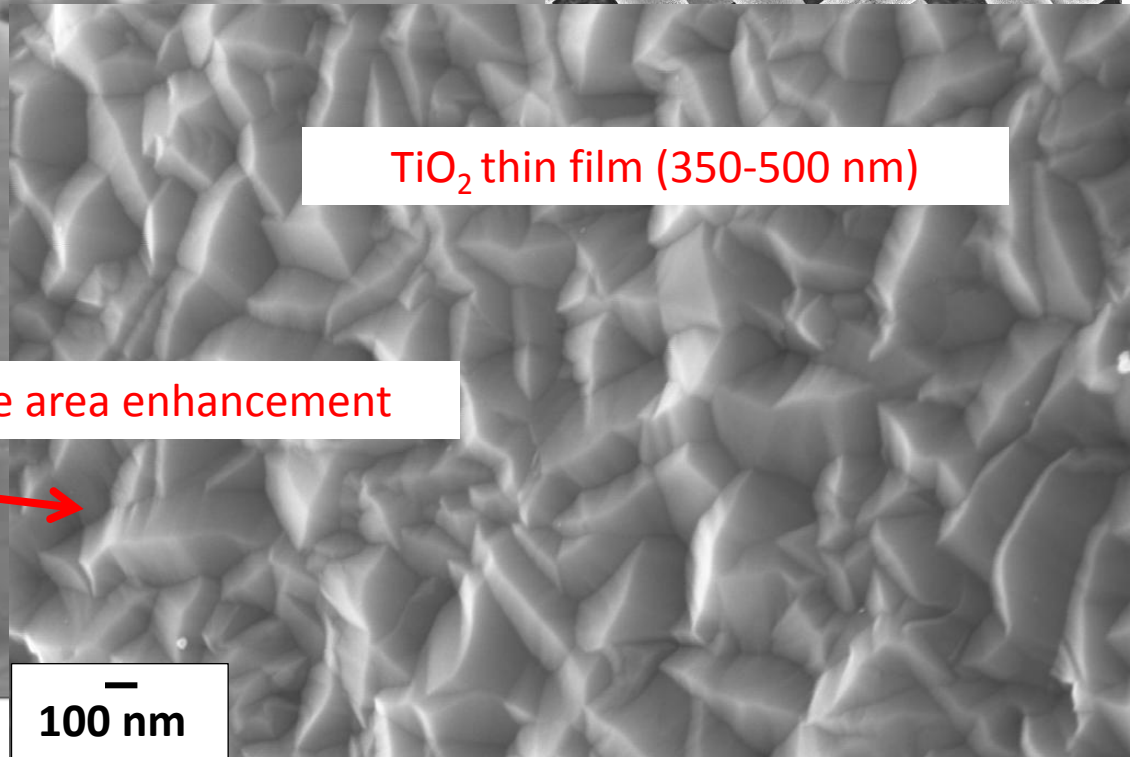
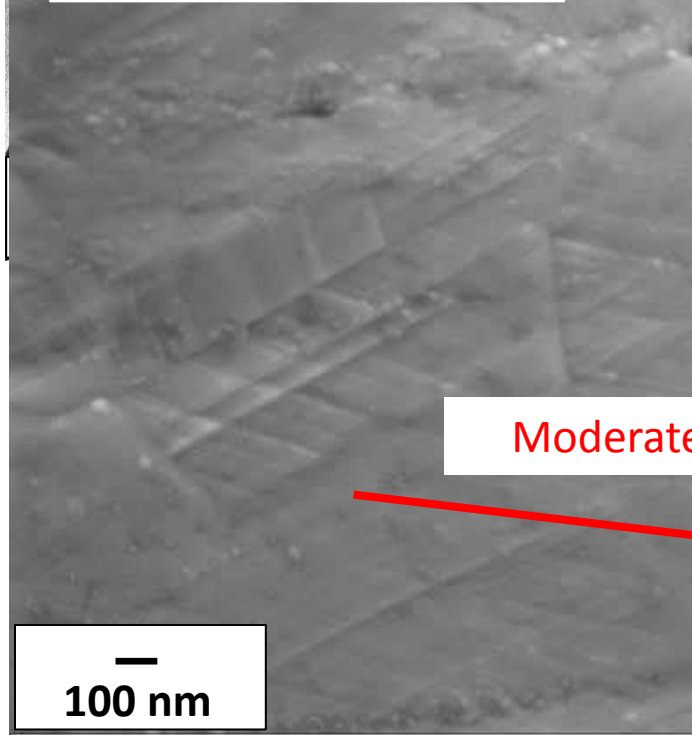




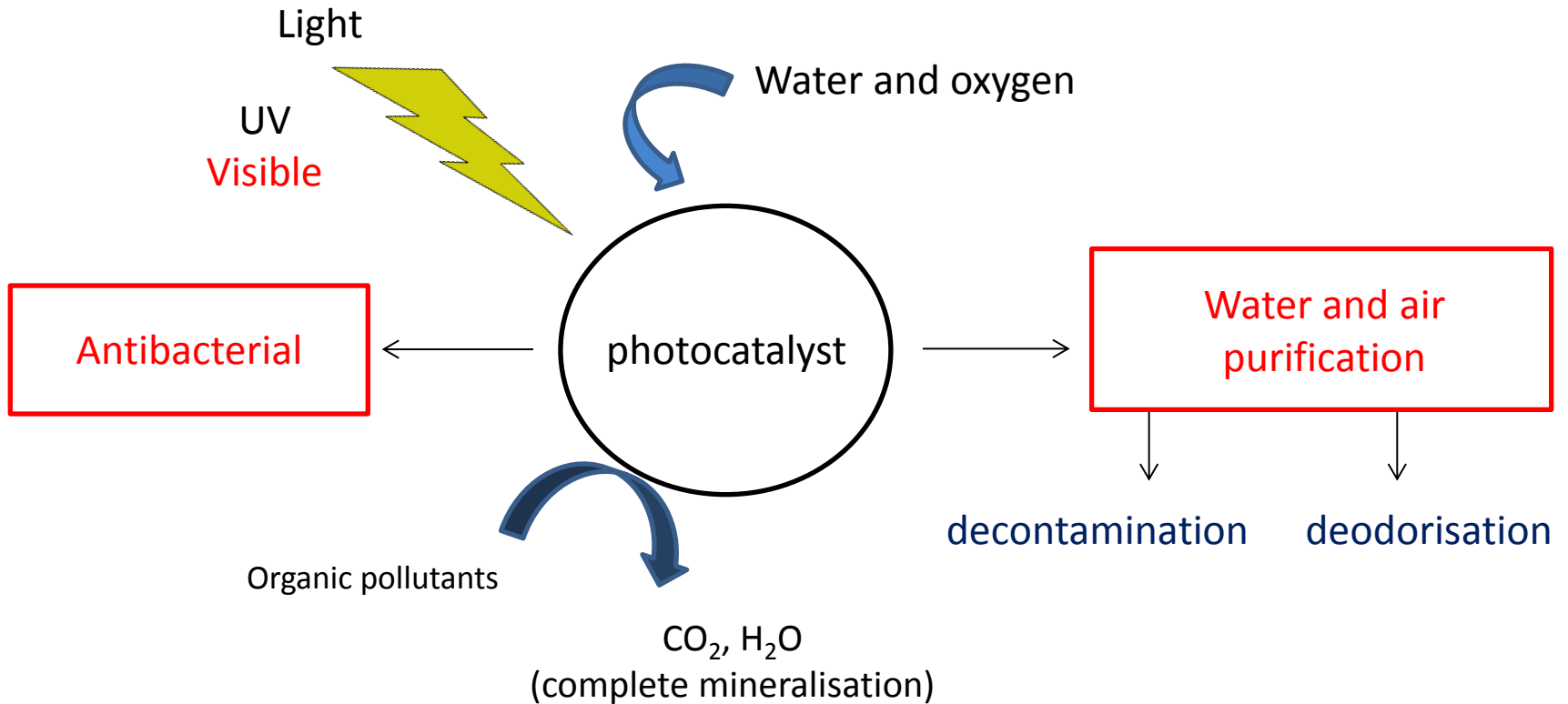
Excellent net conformal coverage.



Not treated net surface



Photocatalytic properties



➔ Available in our laboratory:

- UVC 254 nm 8 W lamp
- 2 UVA 370 nm 9 W lamps
- Xenon 25 W lamp
- LED 13 W lamp

➔ Glass batch reactor, double jacketed with temperature control.

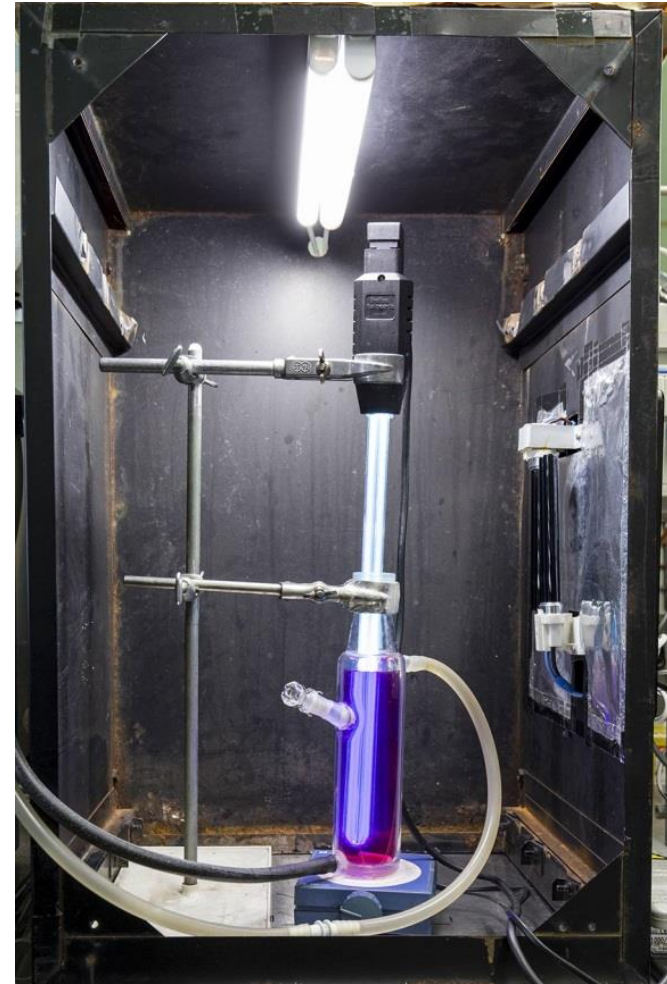
➔ ISO 10678 (2010) protocol test is available.

➔ Pollutant concentration is monitored by UV-Vis spectroscopy

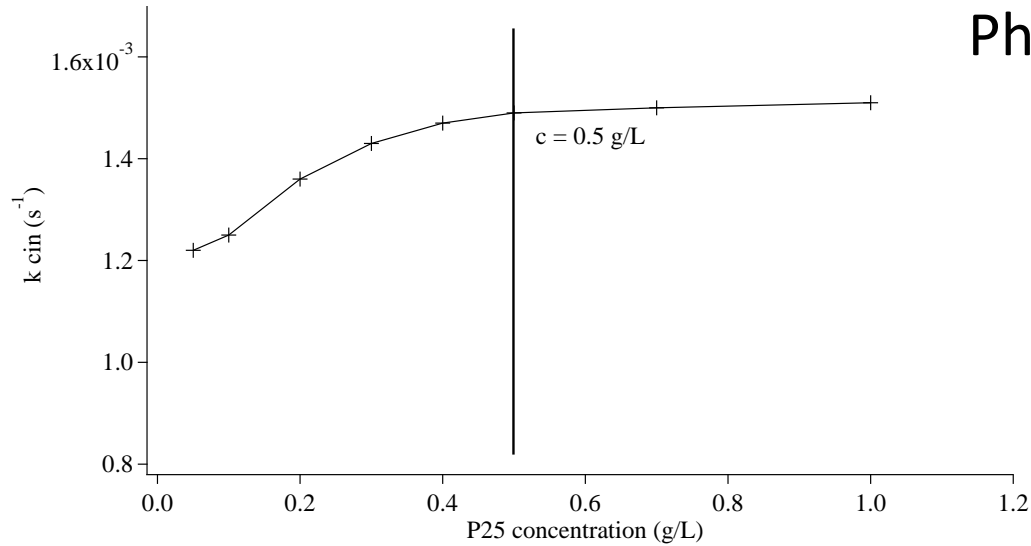
➔ LC-MS protocols are currently under development

➔ Also available the surface monitoring (by colourmeter) for self cleaning surfaces (ex: bleaching of coloured spots)

➔ Reactor chamber for air purification evaluation is under development!

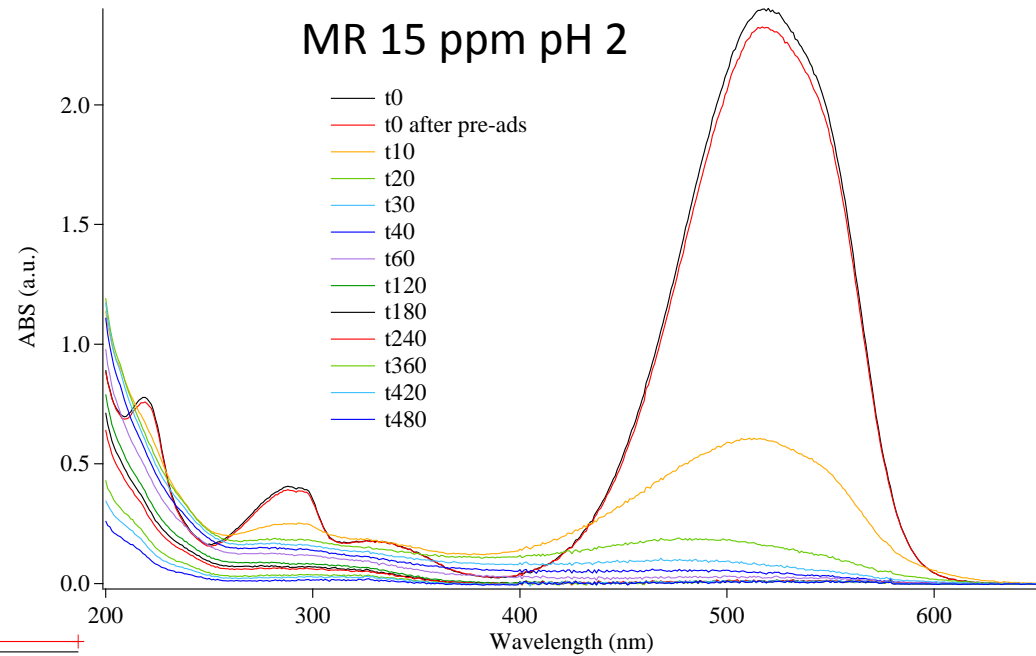
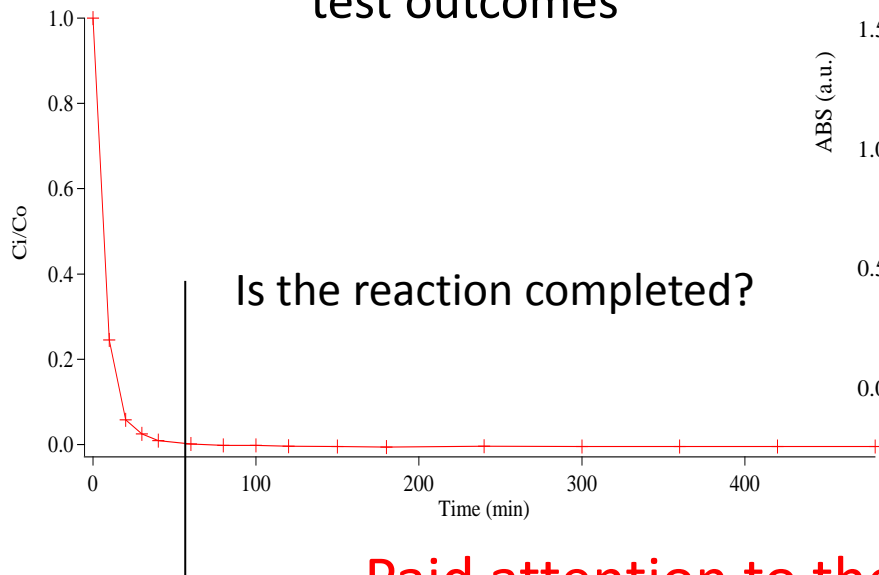


Photocatalytic test on powders



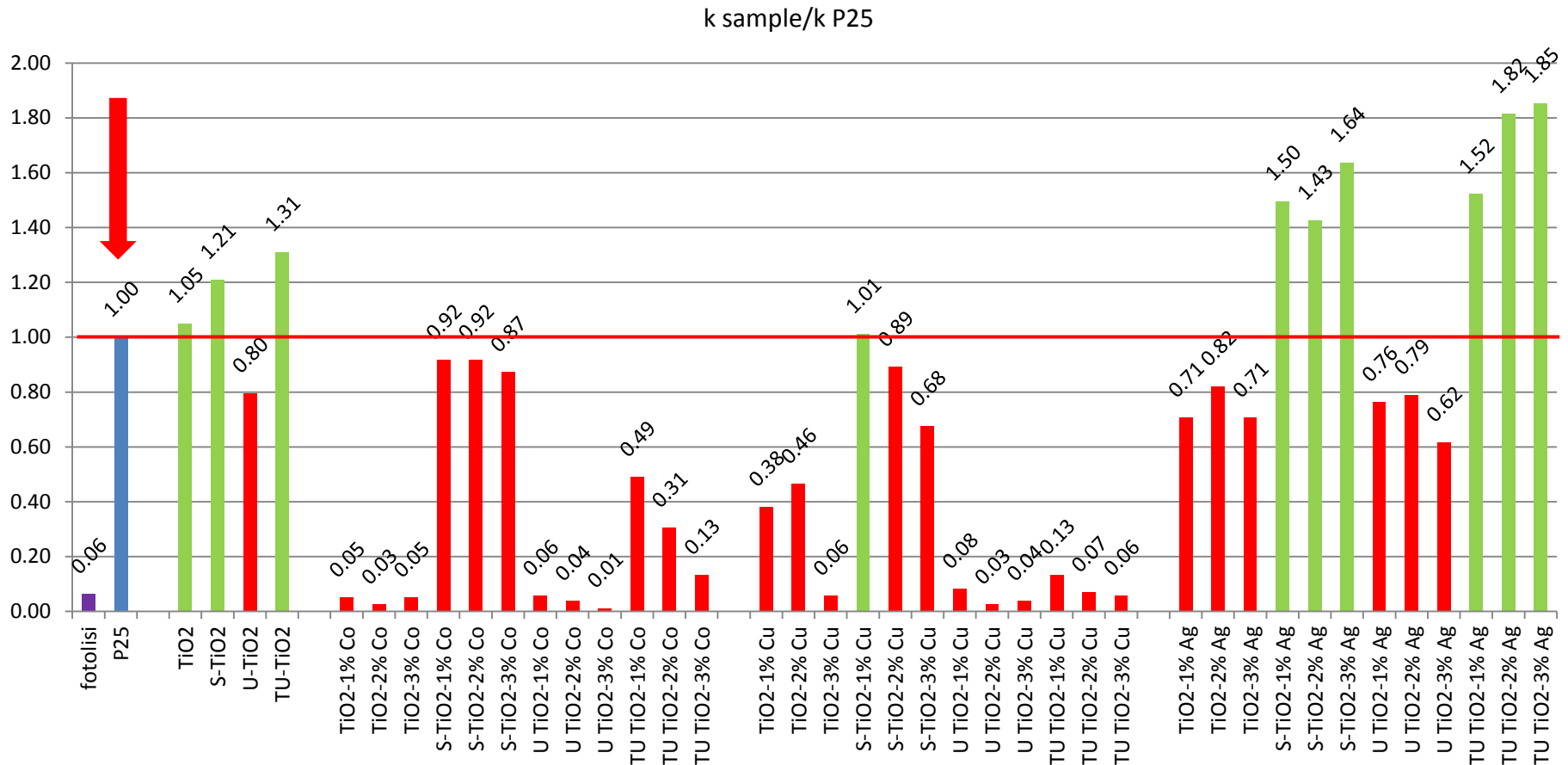
Find the best condition for your photocatalyst!
(concentration, pH, light for optimal activation...)

Typical photocatalytic test outcomes



Paid attention to the reaction by-products!

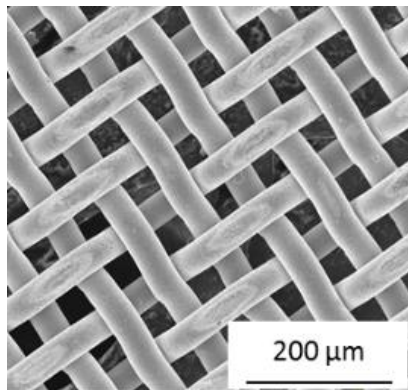
Main photocatalytic test outcomes in TARANTO project for powders



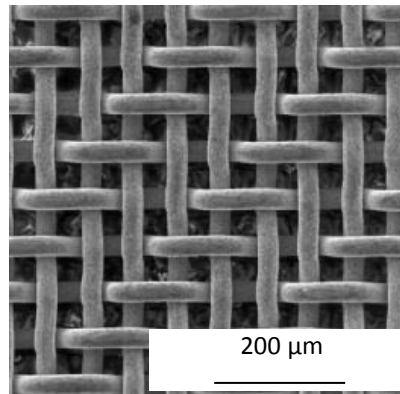
Test conditions: $C_{\text{cat}} = 0,5 \text{ g/L}$, UVC 254 nm 7,7 W lamp, $C_0 \text{ MB} = 4 \text{ ppm}$, $T = 20^\circ\text{C}$,
 dark pre-conditioning = 15', test duration = 40'

Join the MOCVD potentiality with the powder photocatalysts:

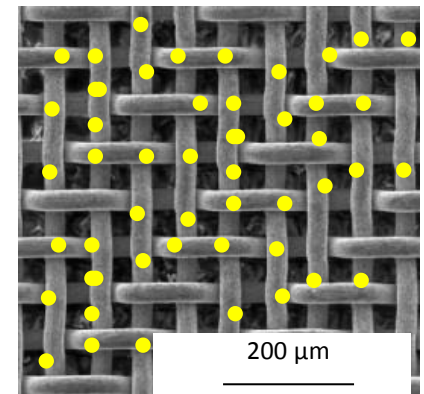
- Make the whole support (stainless steel net) photoactive thanks to TiO_2 thin film deposition
 - Enhance the active surface area (grafting of the powder)
- Simplified catalyst management (easiness in placement-recovering operations)



TiO_2
→
MOCVD



+ TiO_2 NP
→



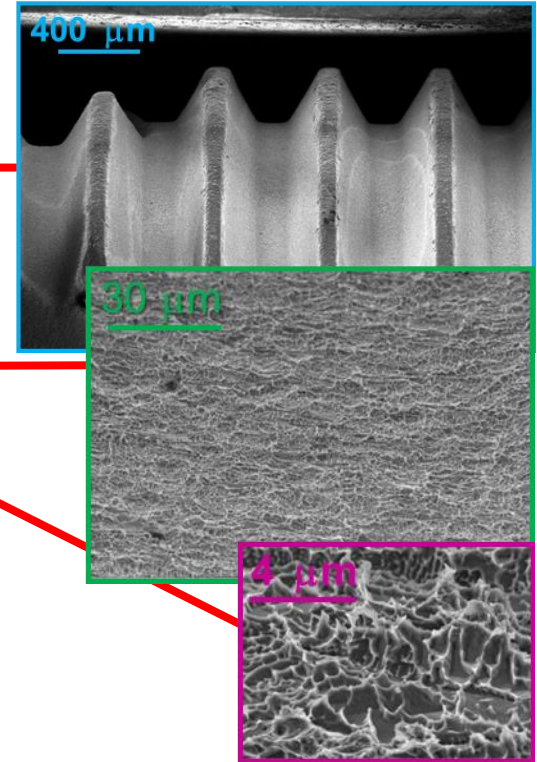
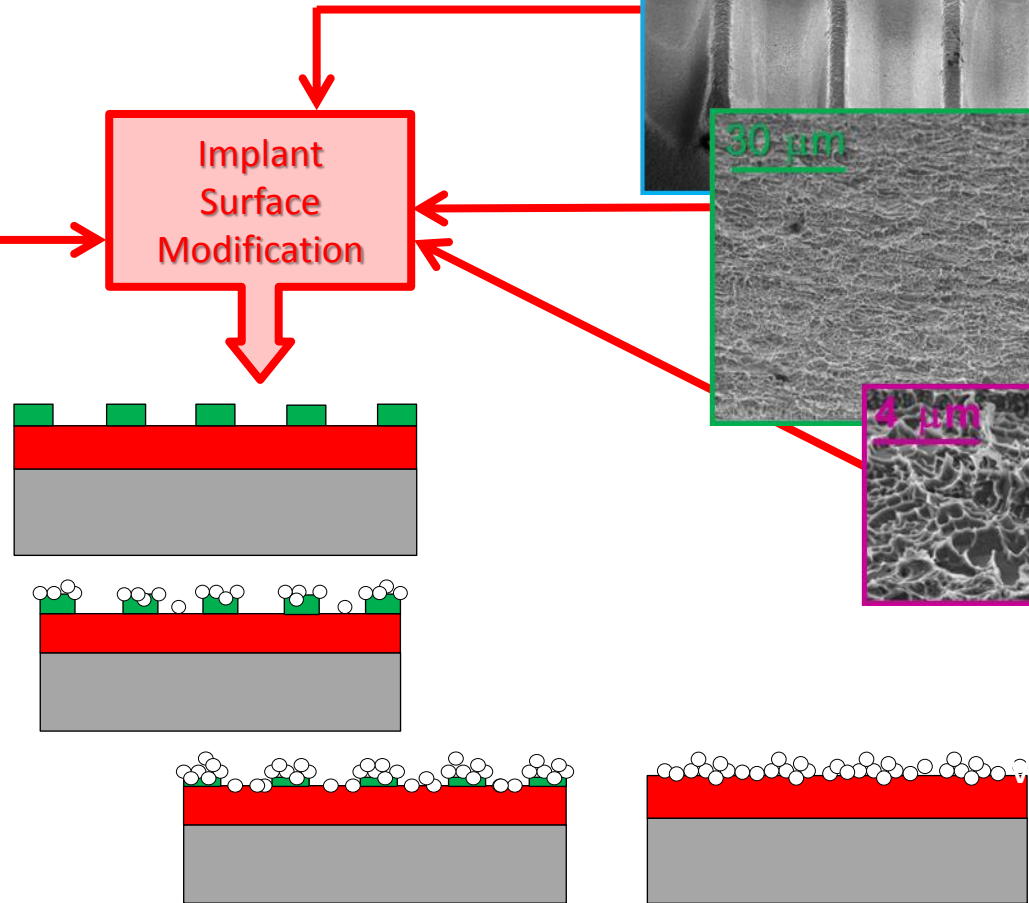
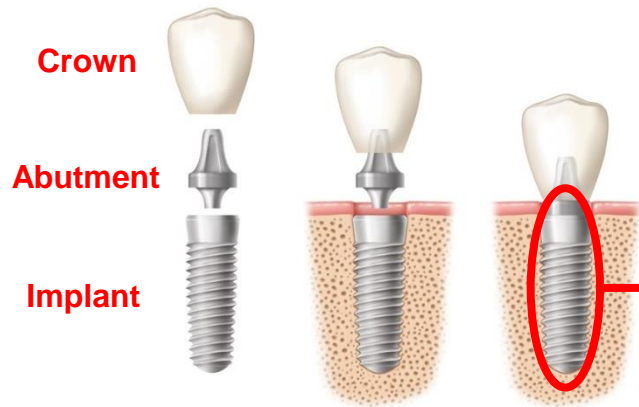
Evaluation of photocatalytic effectiveness on contaminants of emerging concern!

i.e. pharmaceutical and personal care products (PPCPs), drugs, flame retardants, pesticides, perfluorinated compounds...

Biomaterials:

research and development of methodologies for the functionalization of titanium substrates for biomedical applications

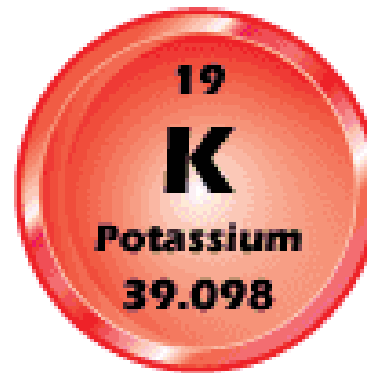
- ✓ 69% of adults ages 35 to 44 have lost **at least one** permanent tooth.
- ✓ By age 74, about 26% of adults have lost **all of their** permanent teeth.



Acknowledgments:

Thanks to the TARANTO team for the coordination
and to the OR2 team for the great cooperation

Thanks to ICMATE and S.C. for
the opportunity in showing
TARANTO project!



for your kind attention!