Micro Wastewater Treatment Systems using Photocatalytic Surfaces (Micro WatTS)

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Outline

- Why Micro WatTS?
- Photocatalysis
- Project Objectives
- Development and Testing of Photocatalytic Surfaces
- Solar Greywater Treatment Unit
- UV Greywater Treatment Unit
- Life Cycle Analysis and Life Cycle Costing
- Conclusions

Micro Wastewater Treatment System using Photocatalytic Surfaces
Grant Week 9th July 2021
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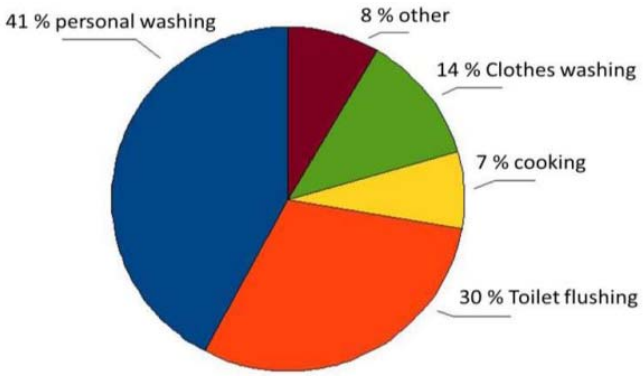
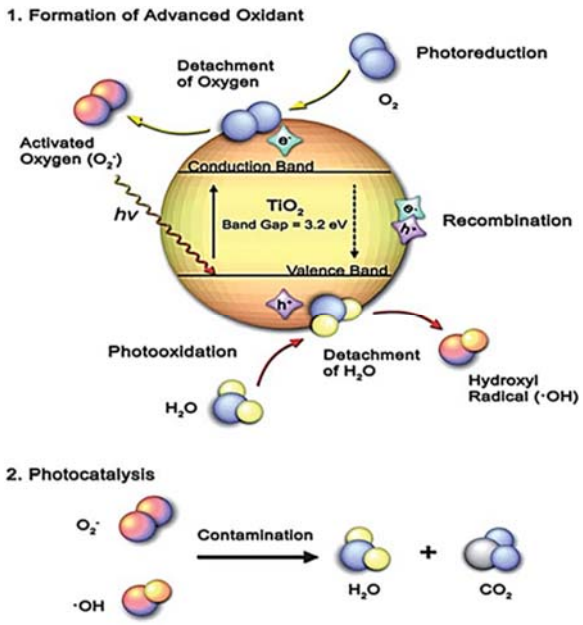
Why Micro WatTS?

- Around 30% of water is used for toilet flushing
- In Malta water is obtained through desalination and groundwater extraction.
- Malta is a highly water stressed state. Potable water is an invaluable resource.
- If treated, water from wash hand basins, showers and laundry can be re-used for non-potable applications e.g. toilet flushing, irrigation and car washing.



Distribution of water consumption in households in Sicily

How? The Photocatalytic Process



Degradation of pollutants using photocatalysis

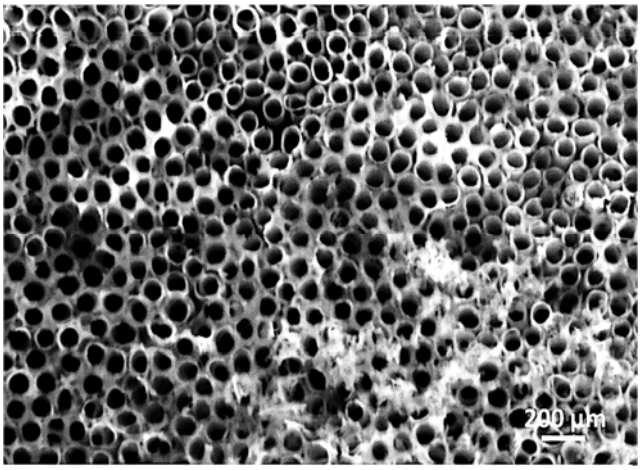
- The photocatalysis requires: light, the photocatalyst and the polluted water.
- No additional chemicals are required.
- The process can degrade a host of different pollutants.
- Photocatalytic degradation of the bacteria renders the greywater safe for re-used.

Project Objectives

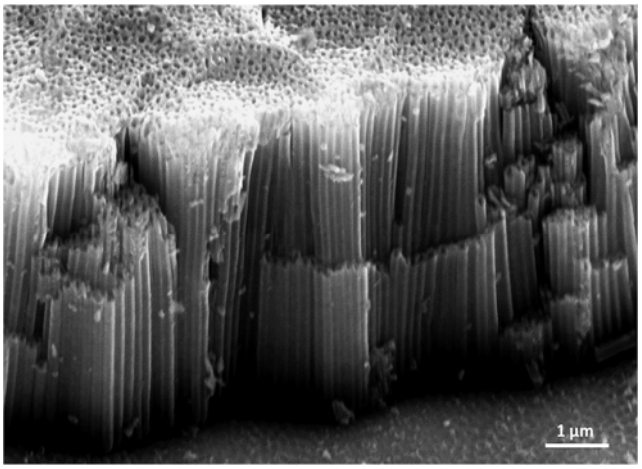
- Developing a number of photocatalytic surfaces.
- Selecting the best performing photocatalytic surface.
- Upscaling the process used for the production of this surface.
- Designing and building solar and UV greywater treatment units loaded with the best performing material.
- Installing and testing these prototype units.

Photocatalytic Surfaces

Mineral based Materials Produced by Anodic Oxidation



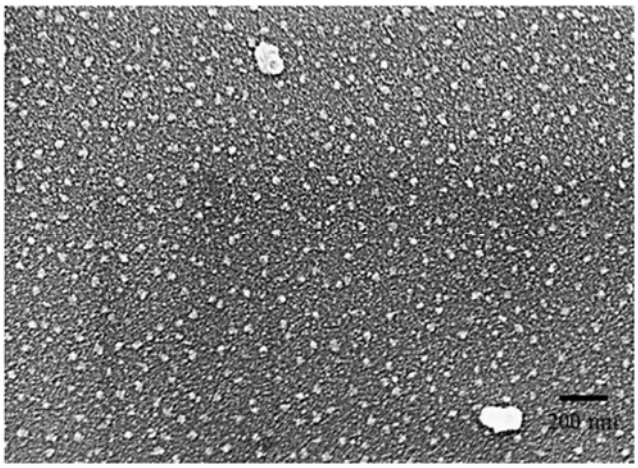
Surface view of TiO_2 Nanotubes



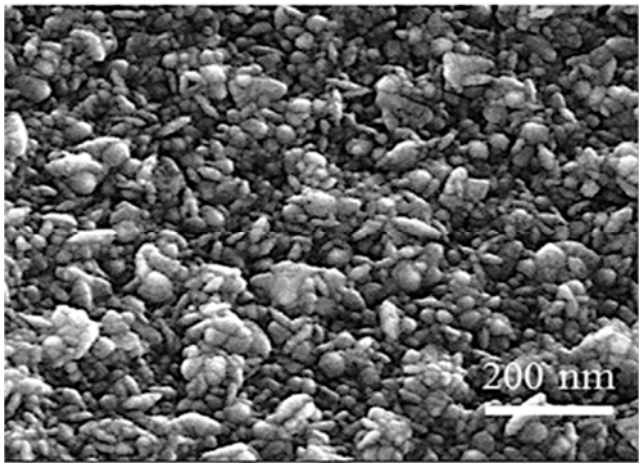
Cross-section of TiO_2 nanotubes

Photocatalytic Surface

Deposited by Atomic layer Deposition (ALD)



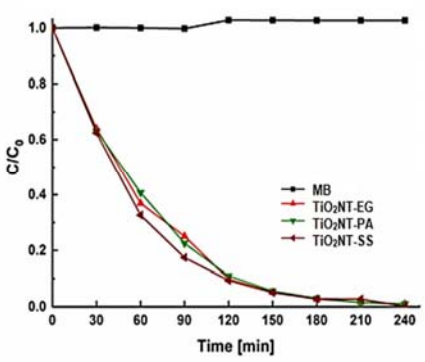
TiO_2 doped with silver nanoparticles

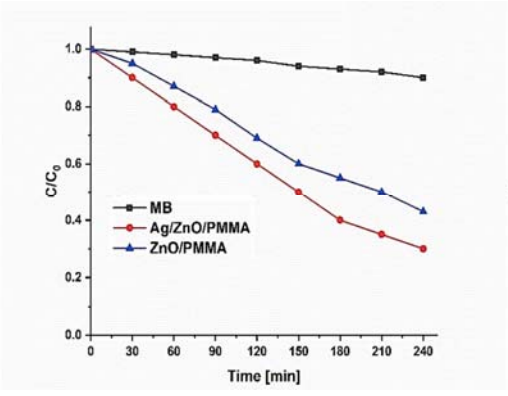


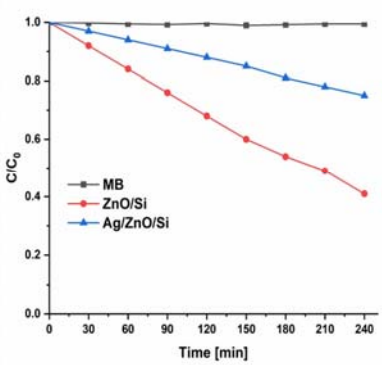
ZnO doped with silver

Pollutant Degradation Ability

Methylene Blue Degradation

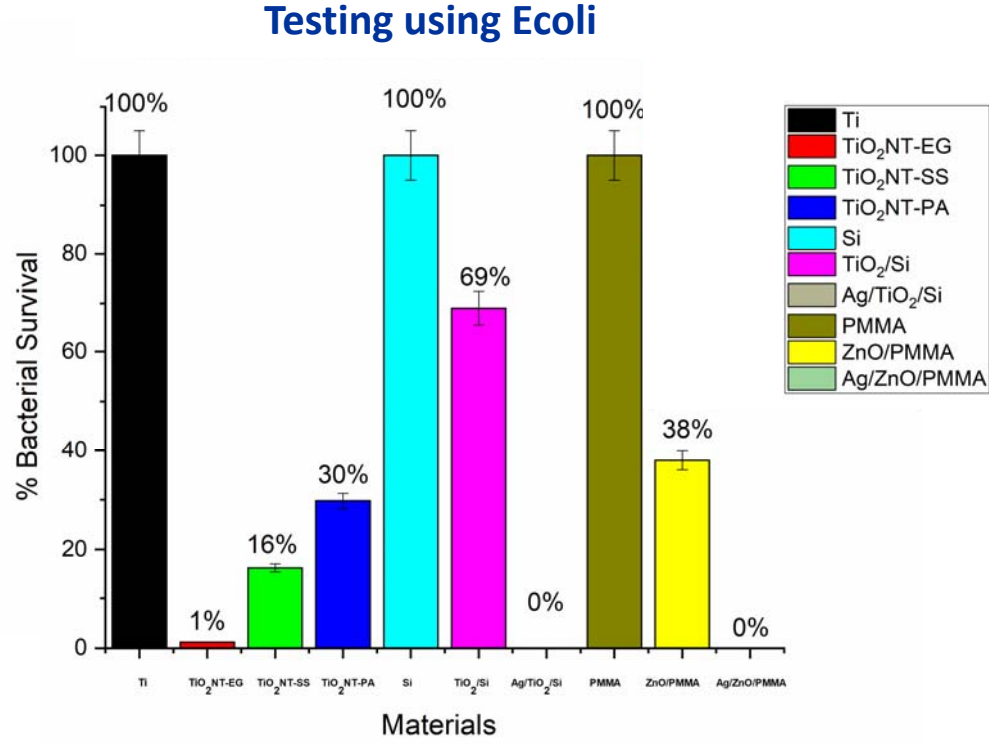






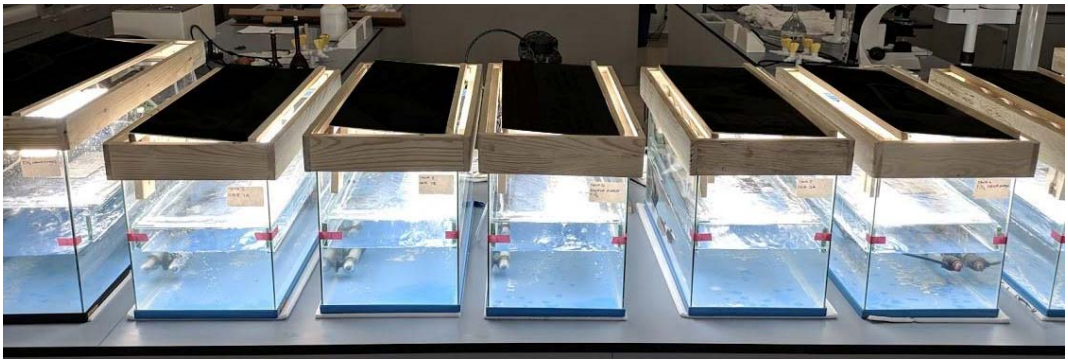
Antibacterial Activity

Testing using Ecoli



Aging of Photocatalytic Surfaces

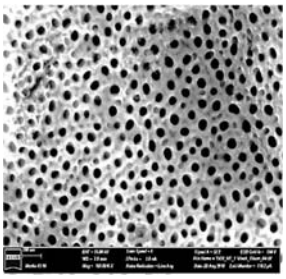
Laboratory Aging Set-up



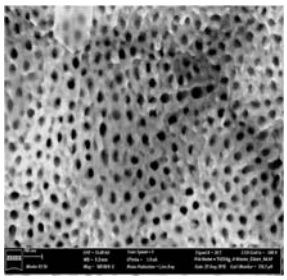
Aging of Photocatalytic Surfaces

Aged TiO_2 Nanotubes

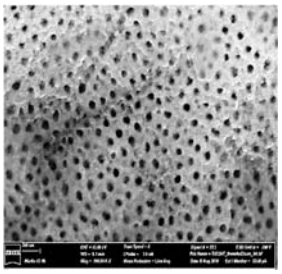
Week 1



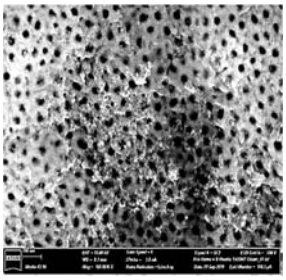
Week 4



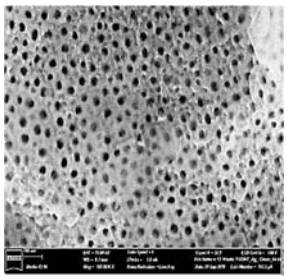
Week 6



Week 8

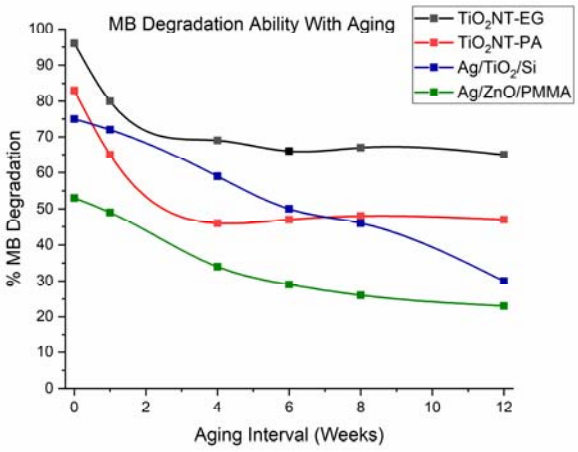


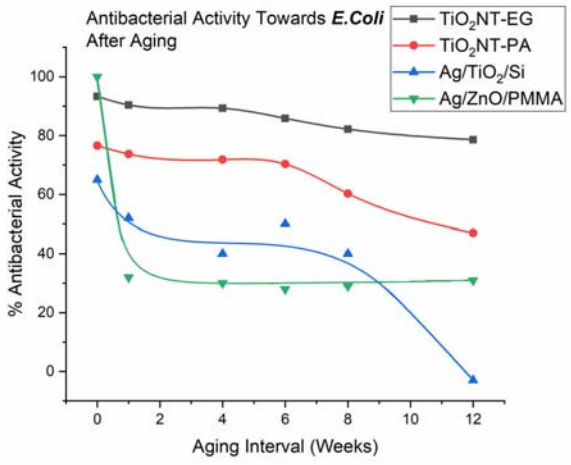
Week 12



Aging of Photocatalytic Surfaces

Photocatalytic Activities of Aged Nanomaterials





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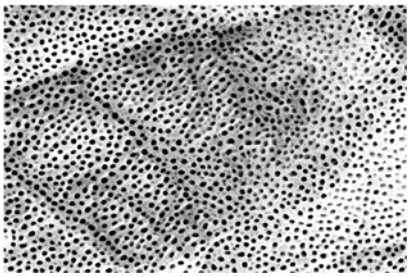
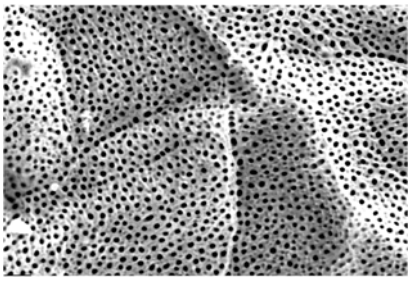
Aging of Photocatalytic Surfaces

Solar Aging of Anodic TiO_2 Nanotubes

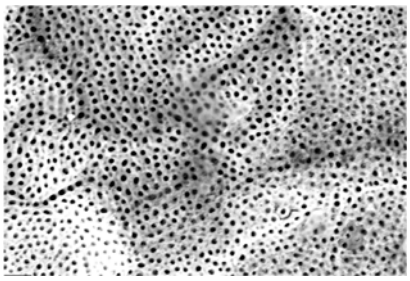
Unaged



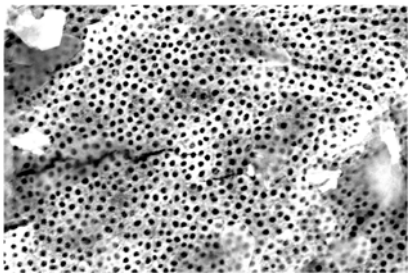
1 Week



4 Weeks



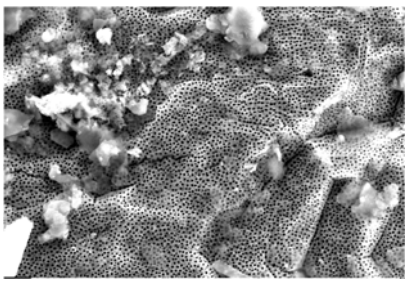
8 Weeks



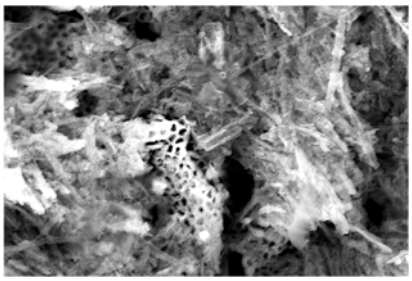
Aging of Photocatalytic Surfaces

Solar Aging of Anodic TiO_2 Nanotubes

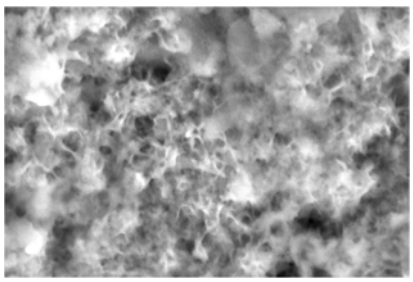
16 Weeks



32 Weeks



52 Weeks



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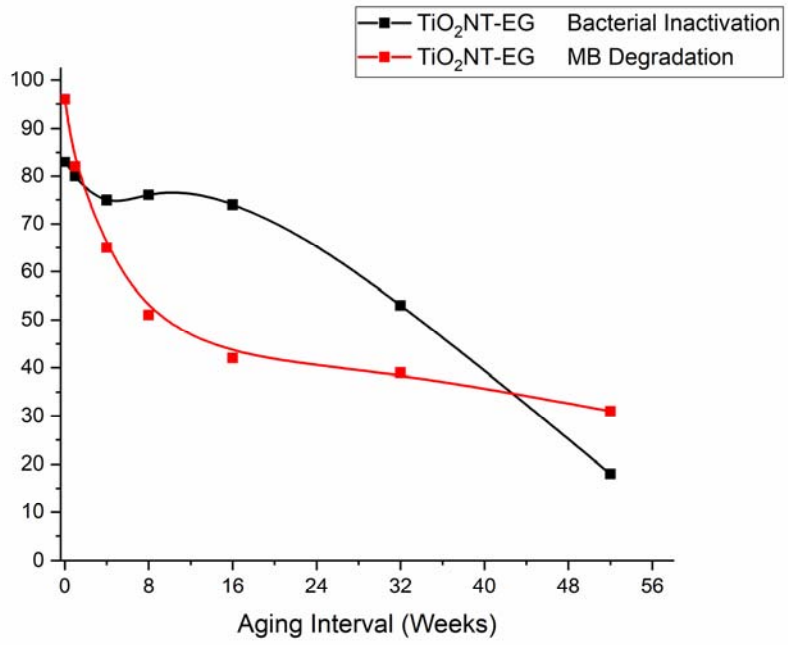
Aging of Photocatalytic Surfaces

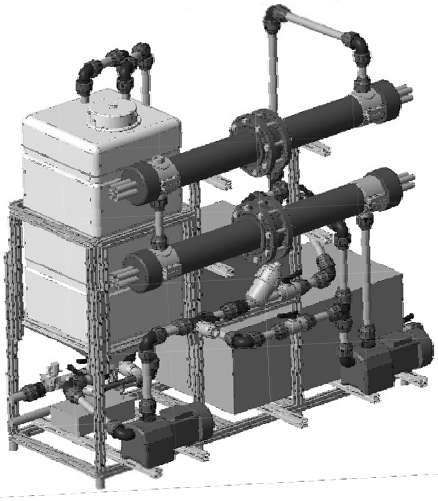
Changes in Photocatalytic Activity following Solar Aging



Solar Units

Solar Grey water Treatment Units

UV Unit

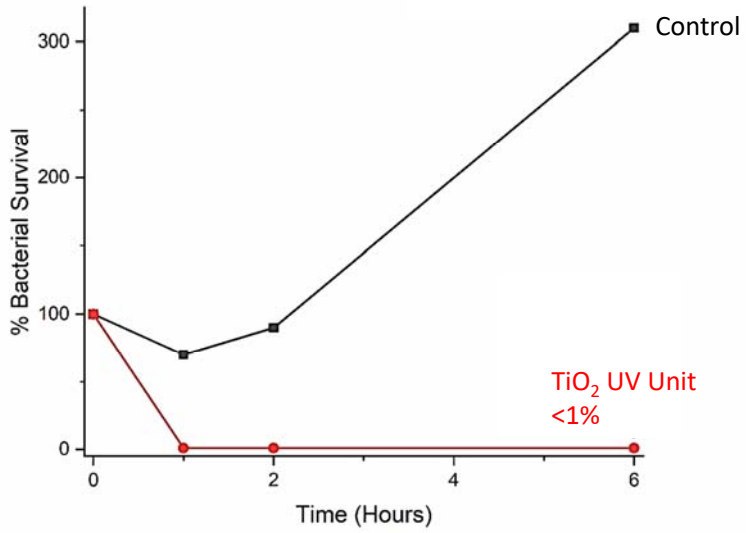


Design of Prototype

Test Unit

Testing of UV Prototype Unit

Antibacterial Activity of UV Prototype



Life Cycle Analysis & Costing

Functional unit: 200L/day x 15 years

- Mains water + wastewater treatment
- Solar unit
- UV unit

- **LCA:** The Use Phase has the highest environmental impact, mainly from the energy consumption.

- **LCC:** The capital cost outweighs all other costs incurred over 15 years.

Conclusions

- The UV unit offers distinct advantages over the solar unit.

- The UV module can produce 200 L of treated water daily when operated for 14 Hours.

- Ongoing work is currently focusing on:
  - Optimizing the process parameters
  - Reducing capital costs and specific energy consumption.

Contacts

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