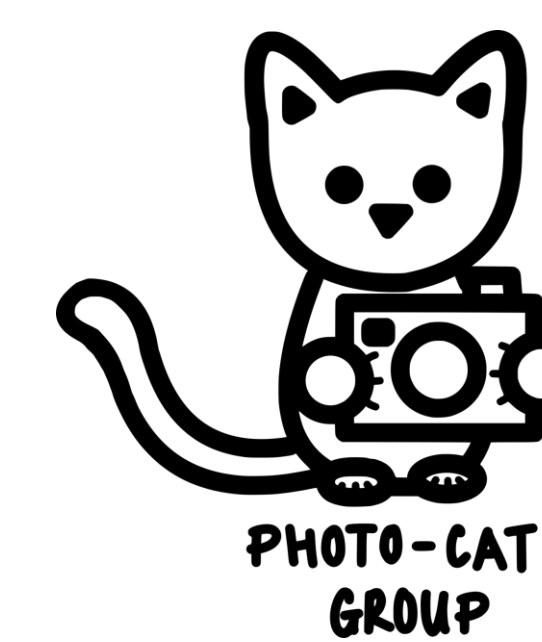


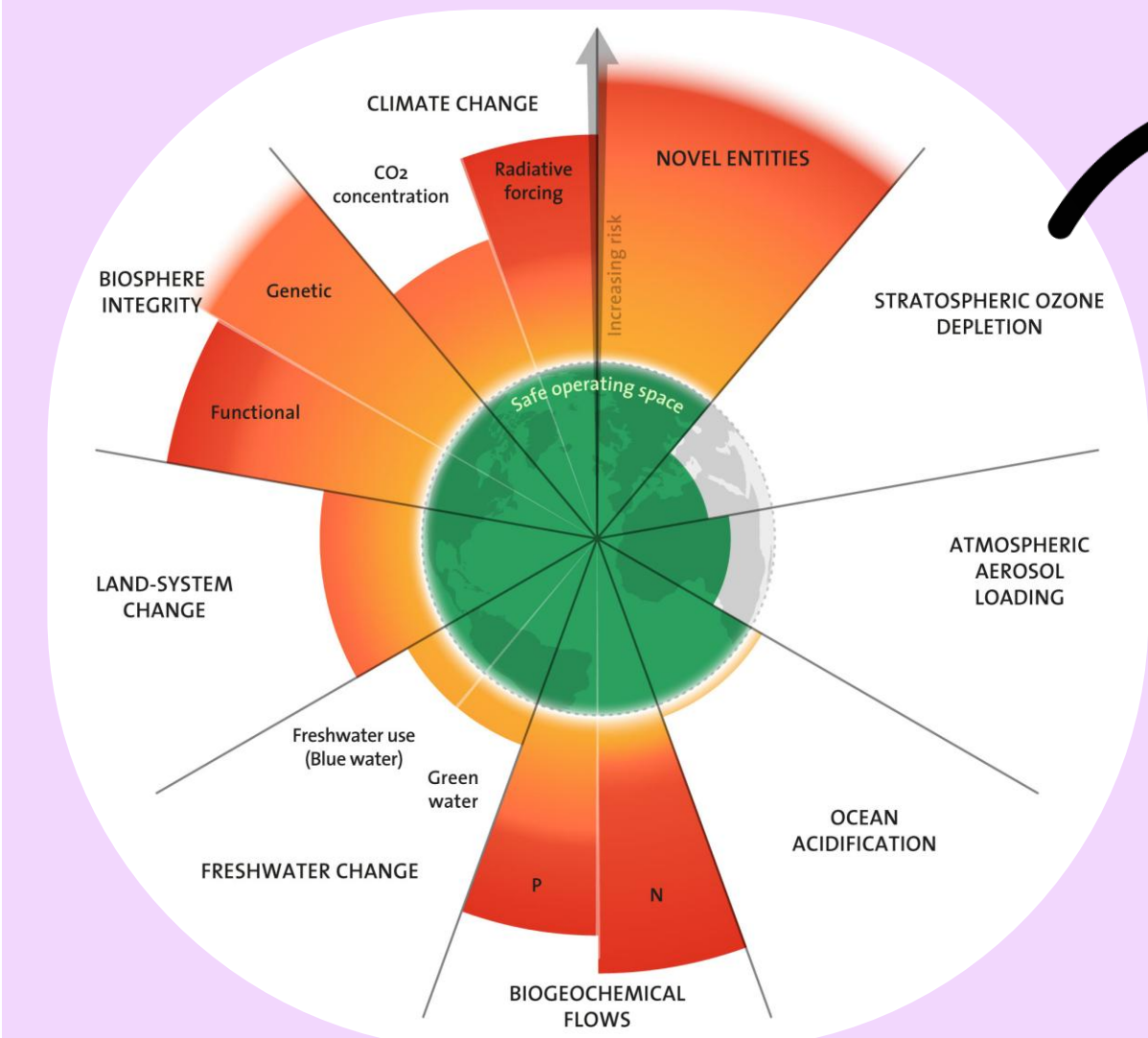
ANbO₃ (A = Na, K, Ag, Li) photocatalysts for the degradation of organic pollutants

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Global Planetary Boundaries



Global assessment shows that the planetary boundary corresponding to **chemical pollution** has been **exceeded**.

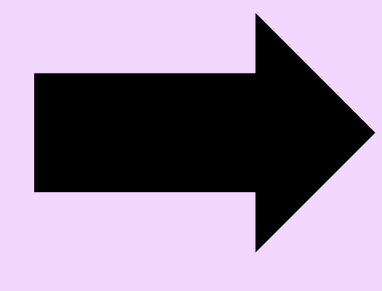
Synthetic organic contaminants include microplastics, pesticides, and wastewater dyes.

They can be found ubiquitously in the environment and pose a **risk to human and environmental health**¹

Credit: Azote for Stockholm Resilience Centre, based on analysis Sakschewski and Caesar et al. 2025¹

Photocatalysis for environmental remediation

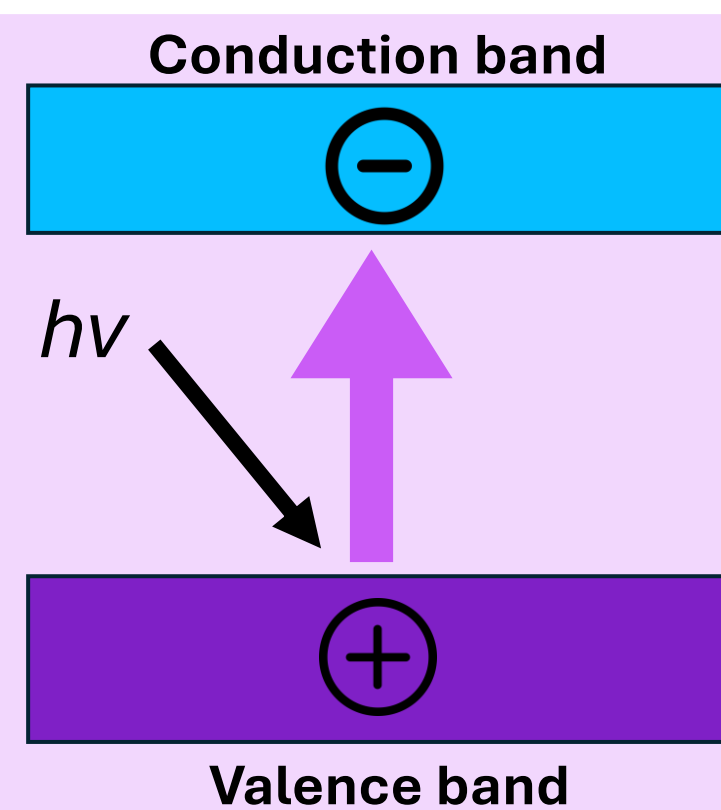
Current wastewater treatment plants



Unsafe and concentrated byproducts²

Photocatalysis as an alternative technique

When a photocatalyst absorbs a photon of light, which is equal to or greater than its bandgap, an electron **is promoted to higher energy levels**



Electrons in the conduction band can **reduce** the strong bonds in pollutants, whilst holes in the valence band **oxidise** them



Goal: To breakdown pollutants into their smallest non-toxic products.

Research Aims

1

To synthesise large redox potential photocatalysts with high pollutant mineralisation efficiency. Current photocatalysts have insufficient redox potentials to break the strong chemical bonds.³

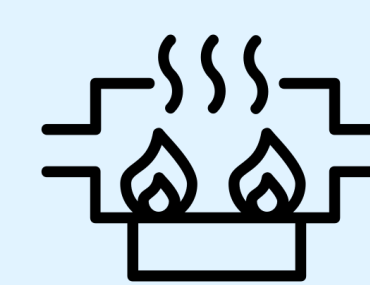
2

To enhance the pollutant mineralisation efficiency of the photocatalysts by lanthanum doping.³

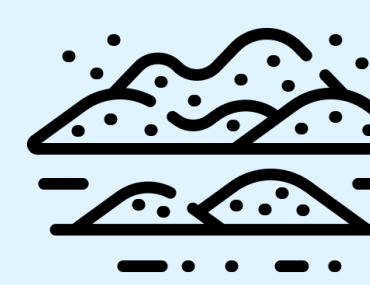
3

To investigate pollutant degradation efficiency in environmental matrices.

Solid State Synthesis



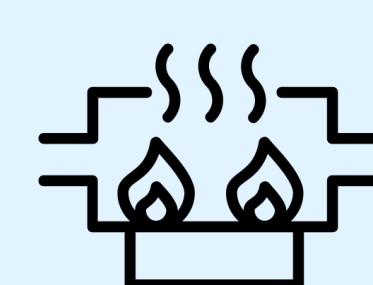
La₂O₃ Pretreatment at 1000 °C for 12 hours



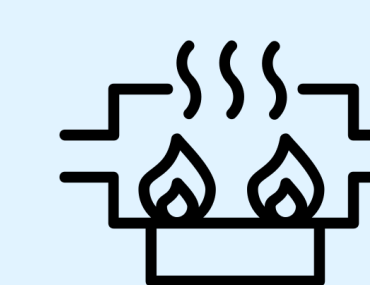
Combine equimolar amounts of Ag₂O, Nb₂O₅, and La₂O₃



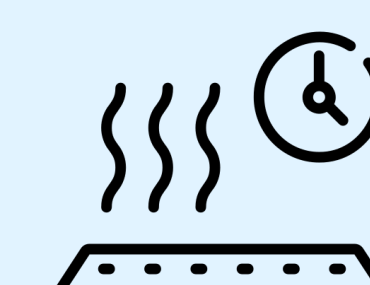
Wet grind in EtOH



Furnace at 800°C for 4 hours



Furnace at 970°C for 7 hours

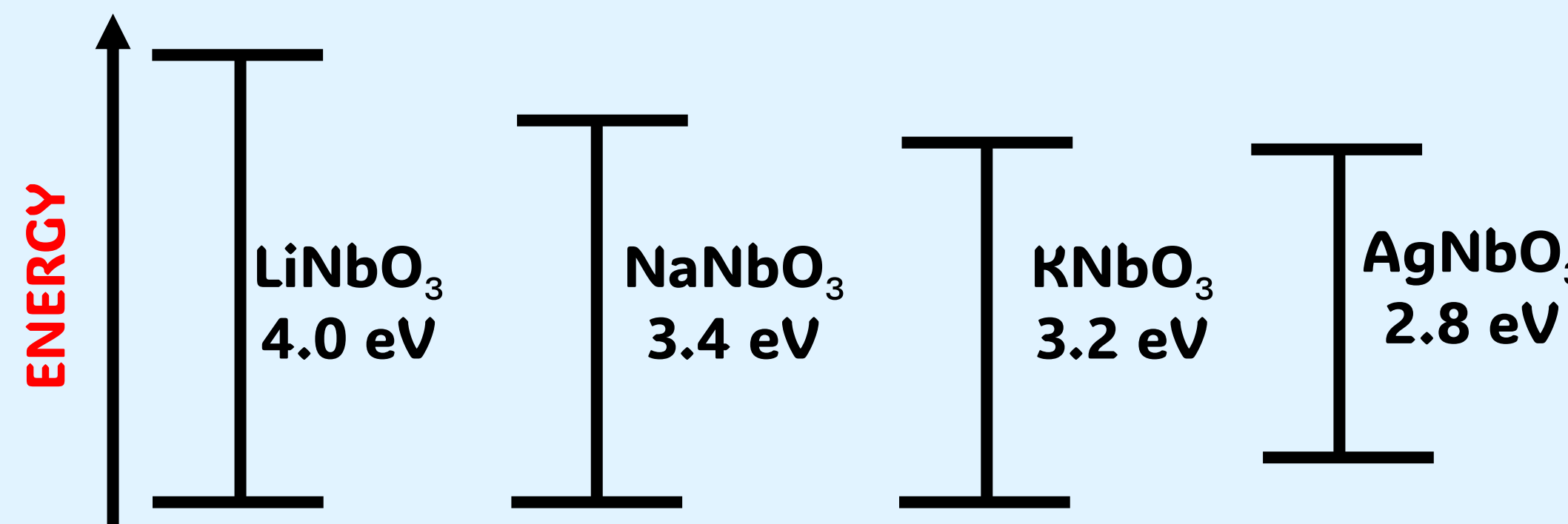


Wash with Milli-Q water, filter and dry



Pure and La-doped AgNbO₃

UV-Vis DRS

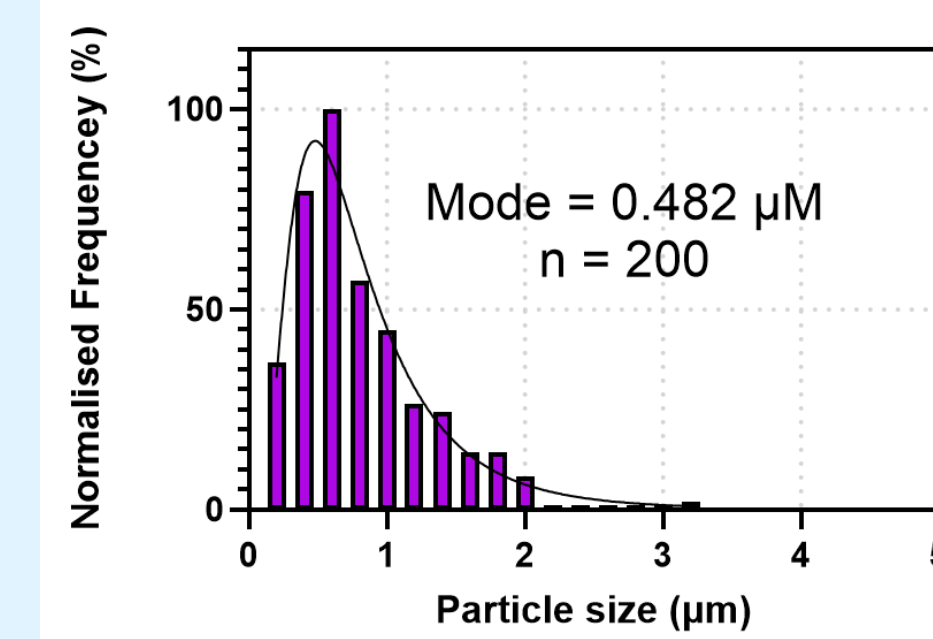
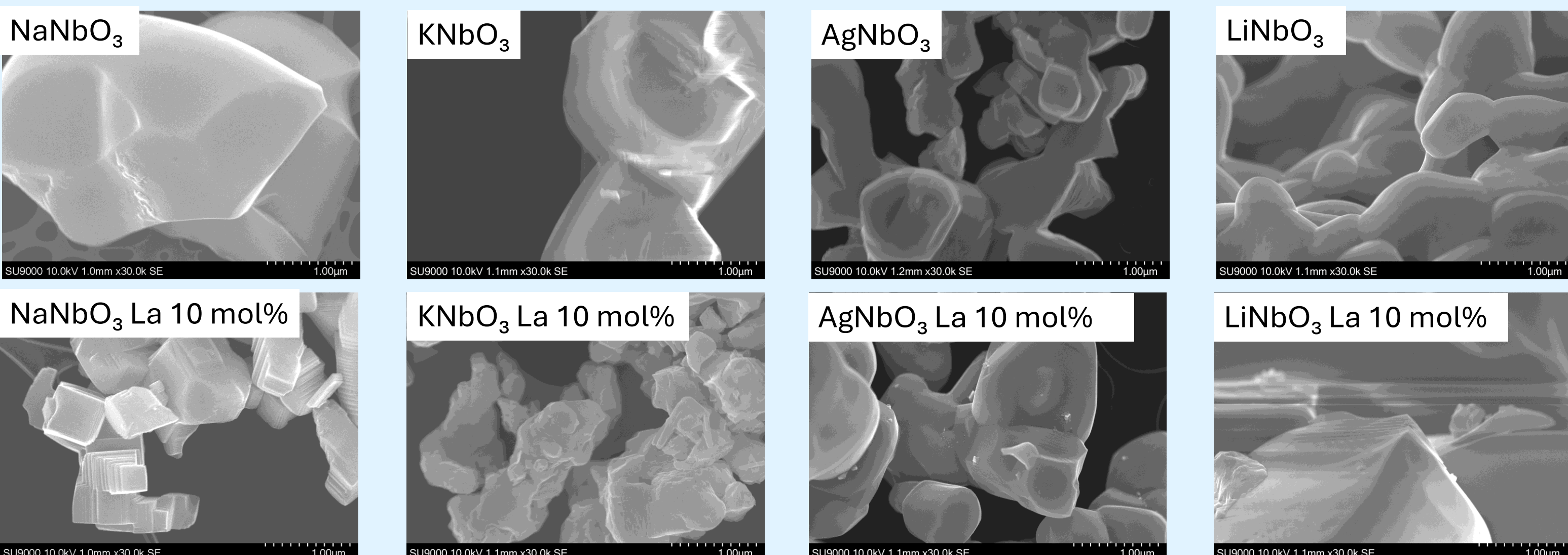


PXRD

NaNbO₃ KNbO₃ and AgNbO₃ have an **orthorhombic crystal structure** whilst LiNbO₃ had a **triclinic crystal structure**.

Each material matched reference spectra.

SEM-EDS analysis



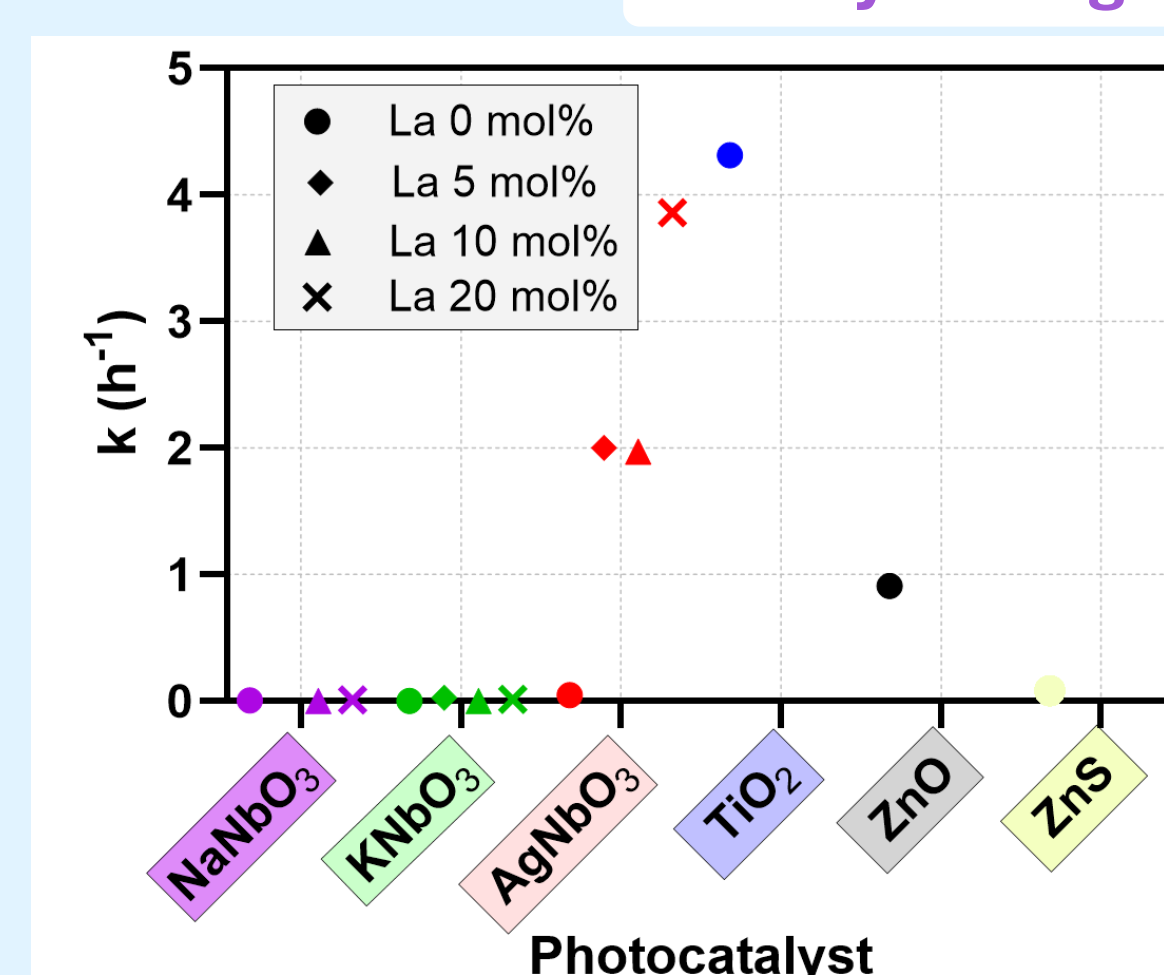
Lanthanum doping resulted in a **decrease** in nanoparticle size.



Elemental analysis confirmed material composition

Pollutant degradation efficiency

Methyl Orange



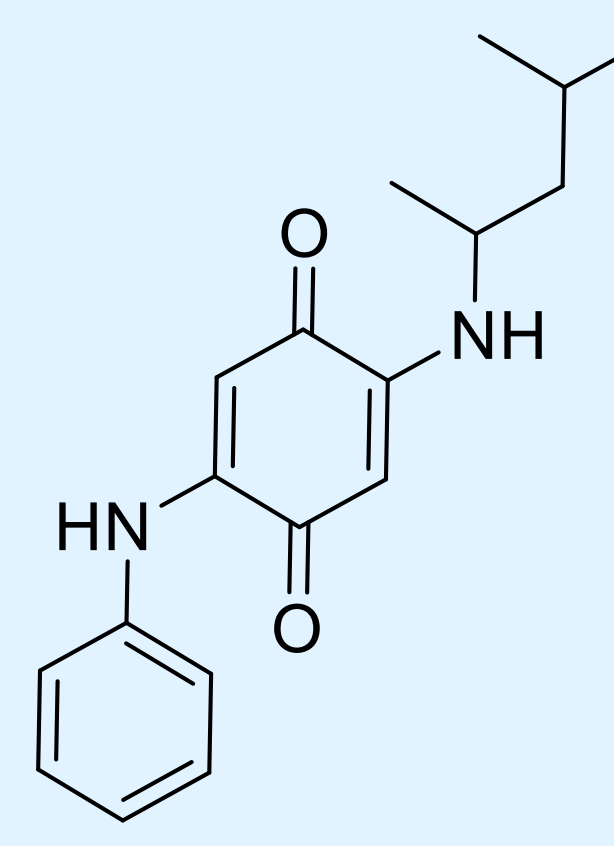
Rate constant (k) of niobates as compared to TiO₂ and ZnO. Change in MO concentration over time was fitted to first-order kinetics.



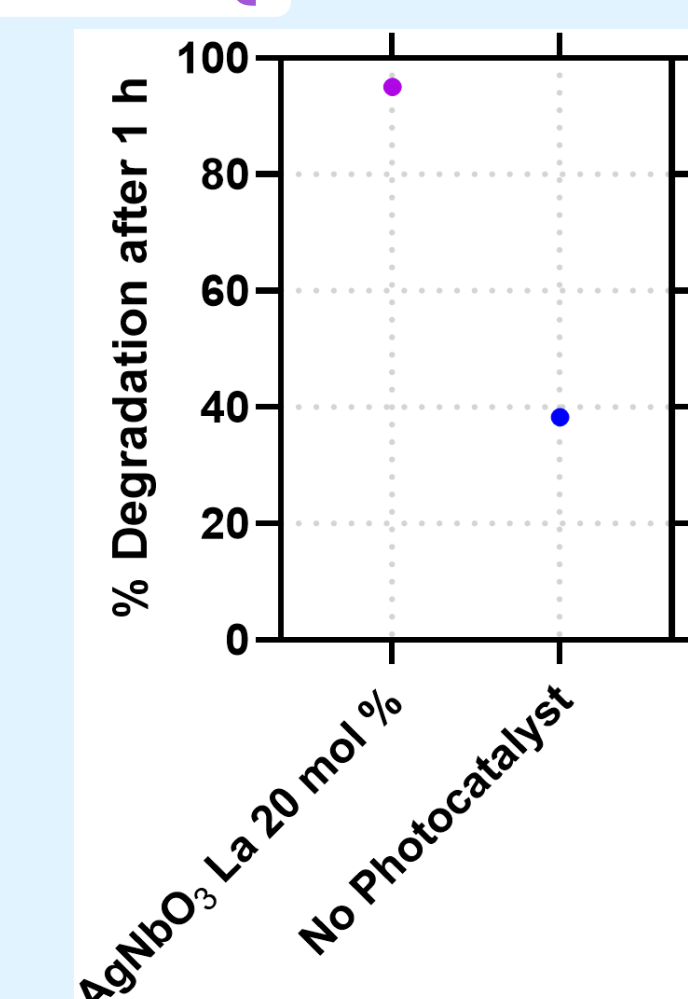
AgNbO₃'s activity is **comparable to TiO₂**



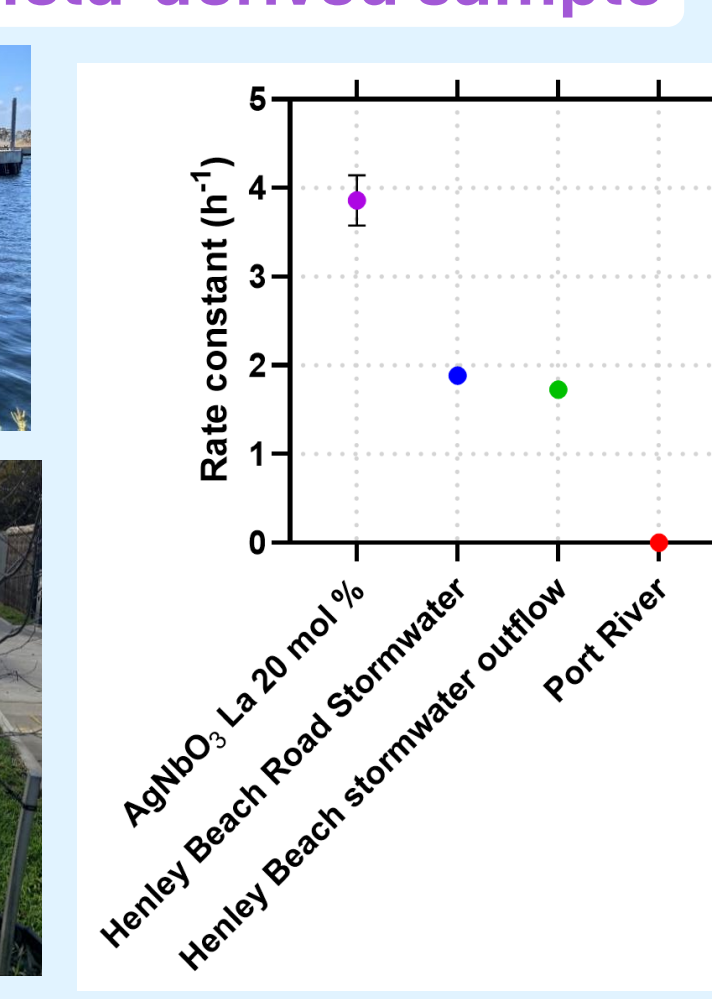
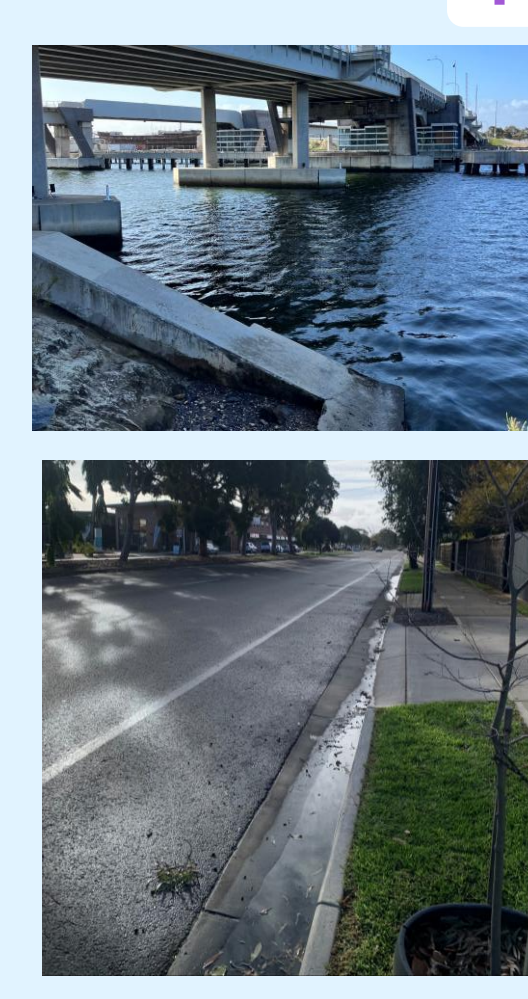
La-doping can **increase activity**



6-PPD-Q

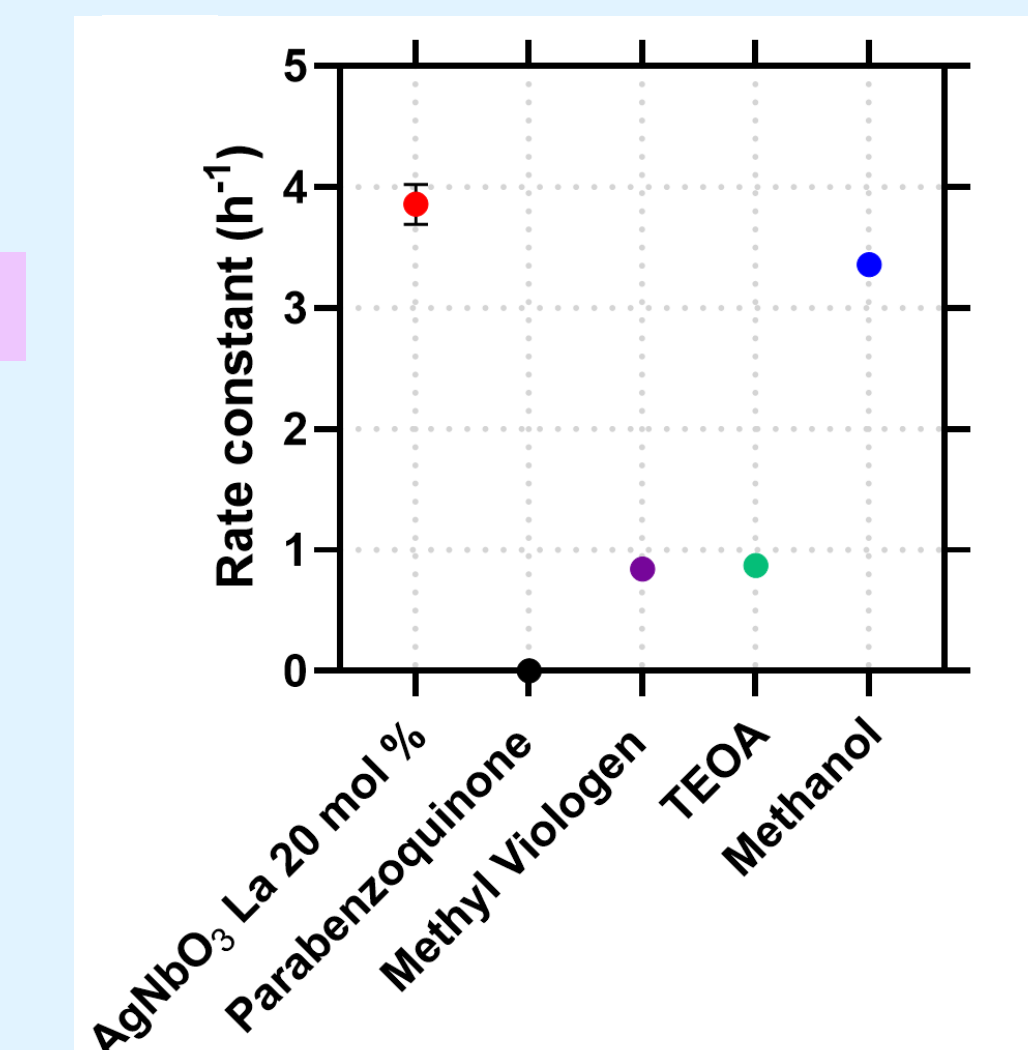
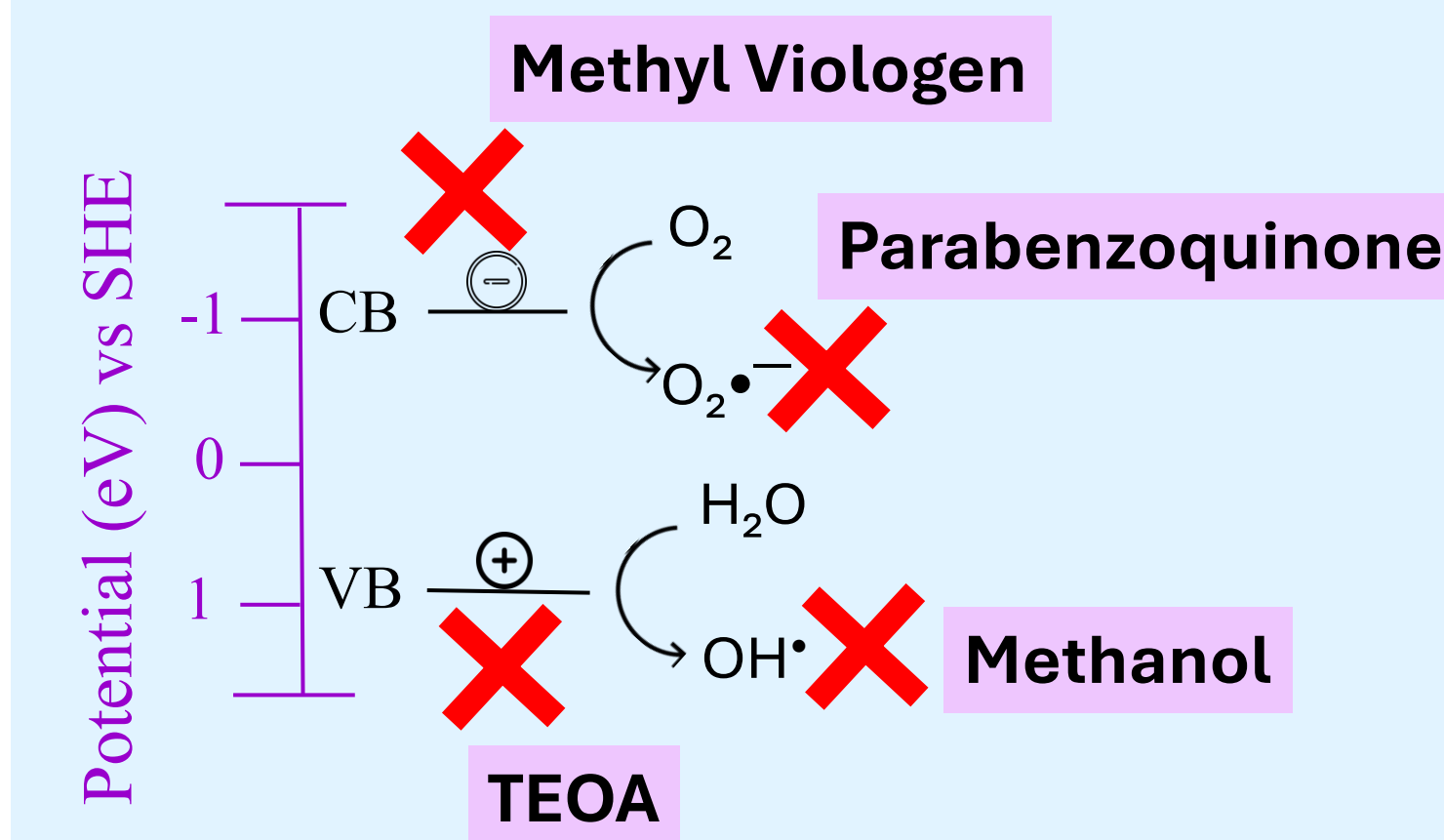


Field-derived sample

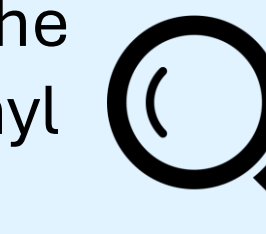


Activity is **reduced**

Mechanism of degradation



The introduction of **parabenzoquinone** caused the **complete reduction** of methyl orange degradation



Thus, the **superoxide radical anion** was responsible for degradation

Conclusions and future work



The AgNbO₃ La 20 mol% sample showed the **highest photocatalytic activity**.

The photocatalyst can degrade a **variety of pollutants** in many conditions.

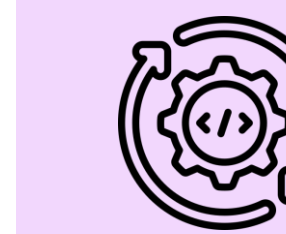
The **superoxide radical anion** drives pollutant degradation.



Continue to lanthanum dope **AgNbO₃** to determine **whether larger degradation efficiencies can be achieved**.



Understand how the **co-analytes** in the field-derived sample **inhibit activity**



Optimise the **synthesis** of the other photocatalysts to **increase activity**

References

- (1) Sakschewski, B.; Caesar, L.; Andersen, L. S.; Bechthold, M.; Bergfeld, L.; Arthur Beusen; Billing, M.; Bodirsky, B. L.; Botsyun, S.; Dennis, D. P.; et al. *Planetary Health Check 2025*; Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany, 2025.
- (2) Tijani, J. O.; Fatoba, O. O.; Madzivire, G.; Petrik, L. F. A Review of Combined Advanced Oxidation Technologies for the Removal of Organic Pollutants from Water. *Water, Air, & Soil Pollution* **2014**, *225* (9), 2102. DOI: 10.1007/s11270-014-2102-y.
- (3) Matthews, R. K.; Nguyen, H. T. L.; Yang, F.; Pukala, T. L.; Evans, J. D.; Shearer, C. J. La Doping ATaO₃ (A = Li, Na, K) to Improve Performance for Photocatalytic Pollutant Degradation. *Chemistry of Materials* **2025**, *37* (10), 3696-3708. DOI: https://doi.org/10.1021/acs.chemmater.4c03443

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