

At-source hospital wastewater treatment to eliminate harmful pharmaceuticals: A novel immobilised approach using UV-LED activated photocatalytic nanomaterials

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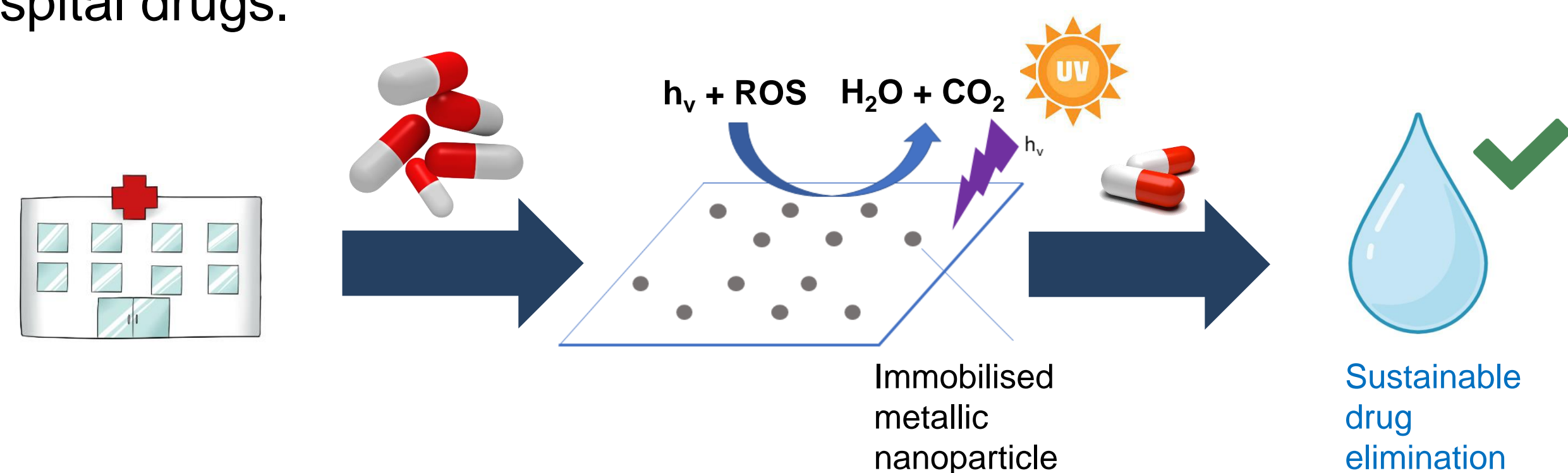
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Introduction

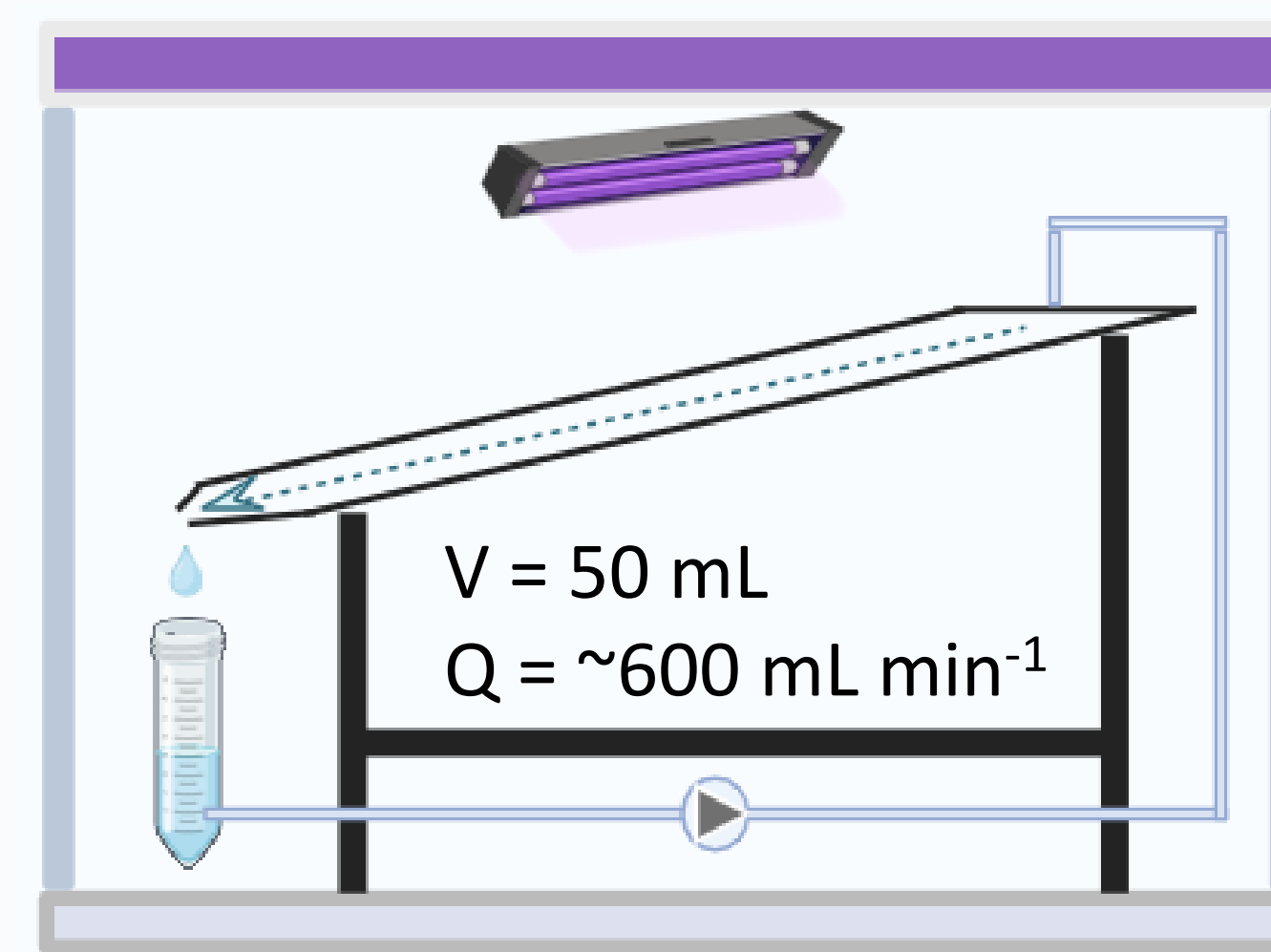
Effective wastewater treatment is urgently needed to eliminate persistent hospital drugs, prevent accumulation in food chains and future risks to human health.

Immobilised photocatalysis, using planar surfaces, is a novel approach to continuously remove drugs and their metabolites in fast-flowing hospital wastewater via light-promoted synthesis of reactive oxygen species (ROS) on the surface of a metallic nanomaterial which can oxidise and eliminate hospital drugs.



Methods

Box coated with UV reflective foil and adhesive
 60W 365nm UV LEDs



Thin-film plate bed photoreactor

Test drugs:
 Paracetamol and amoxicillin in simulated hospital wastewater

Test nanomaterials:
 Inexpensive, UV-light effective (wide band gap)
 Zinc oxide (ZnO) - 3.37 eV

Narrow band gap:
 Copper (II) oxide (CuO) - 1.24 eV

Sampling Interval
 15 – 30 min

Timecourse
 5 – 7 h

Methods/Image

Photocatalytic nanomaterial functionalised onto
 Ø 30 mm ~ 0.15 mm borosilicate support

Powdered ZnO



ZnO thin-film coating



Powdered CuO

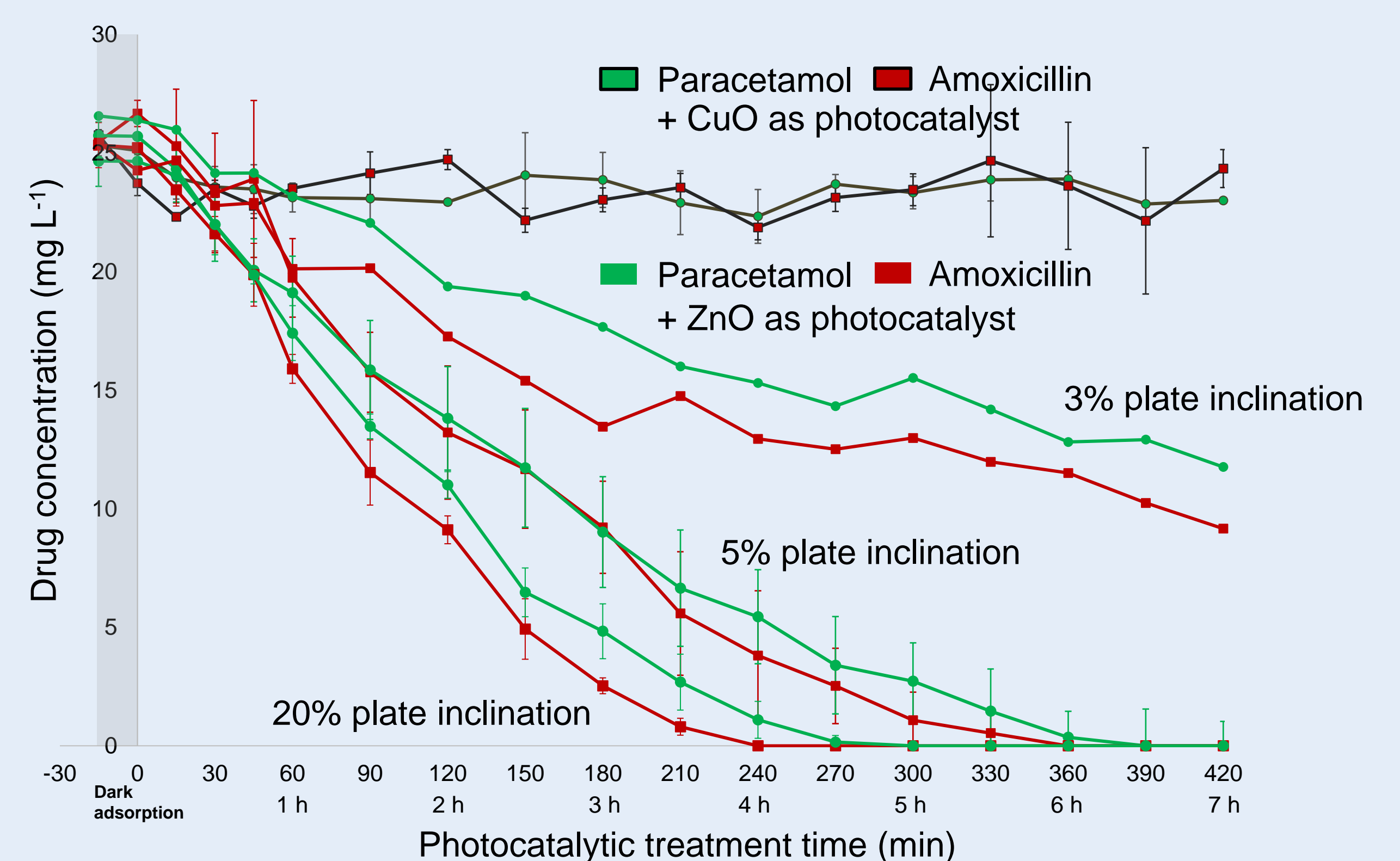


CuO thin-film coating



Results

~ 96% paracetamol decay after 4 h and
 ~ 97% amoxicillin decay after 3.5 h photocatalysis



Methods/Image



ZnO thin-film coated borosilicate slides in plate bed photoreactor

Conclusions/Future

Immobilised photocatalysis using economical 365nm UV-A LEDs and UV-light activated metallic nanomaterials reliably coated onto planar glass surfaces provides an effective, sustainable, reusable solution for the oxidation and elimination of toxic hospital drug mixtures in fast-flowing hospital wastewater.

- Reusability testing of the photocatalytically active surfaces has (so far) shown identical performance in $n = 10$ replicates in one study where the same photocatalytic substrates were reused.
 -> Repeats will be carried out for confirmation
- All five target drugs: amoxicillin, paracetamol, tamoxifen, methotrexate and simvastatin will be photocatalytically treated and measured at environmental ng L^{-1} concentrations.
- Photocatalytic transformation products will be identified using a new time-of-flight (ToF) mass spectrometer.