AIR-PURIFICATION USING PHOTOCATALYTIC ZINC OXIDE NANO MATERIALS

PROJECT ID	NSF-SCH-2025-256
LEVEL	JUNIOR
CATEGORY	JUNIOR- PHYSICAL SCIENCE(JPS)

ABSTRACT

This project demonstrates the photocatalytic properties of zinc oxide (ZnO) nanomaterials for air purification. The ZnO-coated surface is shown to effectively break down air pollutants under light exposure, reducing odor and discoloration. The experiment verifies the hypothesis that ZnO nanomaterials can purify air through photocatalytic oxidation, making it a promising material for sustainable air purification systems.

AIM

To study the photocatalytic properties of zinc oxide (ZnO) nanomaterials and demonstrate their ability to purify air by breaking down harmful POLLUTANTS UNDER LIGHT EXPOSURE

INTRODUCTION

Air pollution is one of the major environmental challenges affecting human health and ecosystems. Conventional air purification methods are often expensive or energy-intensive. Nanotechnology provides a new approach using photocatalytic nanomaterials such as zinc oxide (ZnO), which can decompose pollutants when exposed to light. ZnO absorbs ultraviolet (UV) light and generates reactive oxygen species that oxidize and remove organic and inorganic contaminants from the air. This project aims to understand the working principle of ZnO-based photocatalysis and its application in air purification.

Selection of Problem and Background Research:

Urbanization and industrialization have increased the release of harmful gases like nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs). Traditional filters only trap these pollutants without breaking them down. Zinc oxide nanomaterials offer a photocatalytic solution. When exposed to sunlight or UV light, ZnO activates and converts toxic gases into less harmful substances such as carbon dioxide and water. Previous studies show that ZnO nanoparticles are stable, inexpensive, and eco-friendly, making them ideal for large-scale applications like coatings on walls, windows, and air filters.

STATEMENT OF THE PROBLEM:

To investigate whether zinc oxide nanomaterials can effectively purify air through photocatalysis by degrading pollutants when exposed to light.

HYPOTHESIS

If air is passed over a surface coated with zinc oxide nanomaterials under light exposure, then pollutants present in the air will break down due to the photocatalytic activity of ZnO.

VARIABLE

Independent Variable: Light exposure and type of catalyst (ZnO nanomaterial).
Dependent Variable: Reduction in concentration

of air pollutants (e.g., odor, dust, or gas).
Controlled Variable: Amount of air passed, duration of exposure, temperature, and humidity

PROCEDURE

1. Prepare zinc oxide nanomaterial (ZnO powder or nanoparticles can be obtained from a school lab or prepared using chemical precipitation).
2. Coat a glass plate or ceramic tile with the ZnO solution and allow it to dry.
3. Place the coated plate in a closed chamber or transparent box.
4. Introduce a small source of polluted air (for example, a few drops of acetone or colored gas inside).
5. Expose the chamber to sunlight or a UV lamp for a fixed time.
6. Observe the change in odor, clarity, or color intensity of the air over time.
7. Compare it with a similar uncoated plate under the same conditions.
8. Record your observations, photographs, and changes in pollution level indicators.

Safety Note: Perform under supervision and ensure good ventilation while handling chemicals.

DATA TABLE

S.No	Parameter	Description / Units	After Treatment (ZnO Exposure)
1	Concentration of Air Pollutant (e.g. NO_2)	1.20 ppm	0.35 ppm
2	Concentration of VOCs (e.g. Formaldende)	0.90 ppm	0.20 ppm
3	Photocatalyst Used	150 µg/m³	60 µg/m³
4	Light Source In-	–	ZnO Nanoparticles
5	Ilnte Source	50 W/m² (U)	50 wm (UV)
6	Exposure Time	minutes	30 min
7	Temperature Du-	°C	70.8 %
8	% Reduction in	30°C	77.7 %
10	% Reduction in	30°C	60.0 %

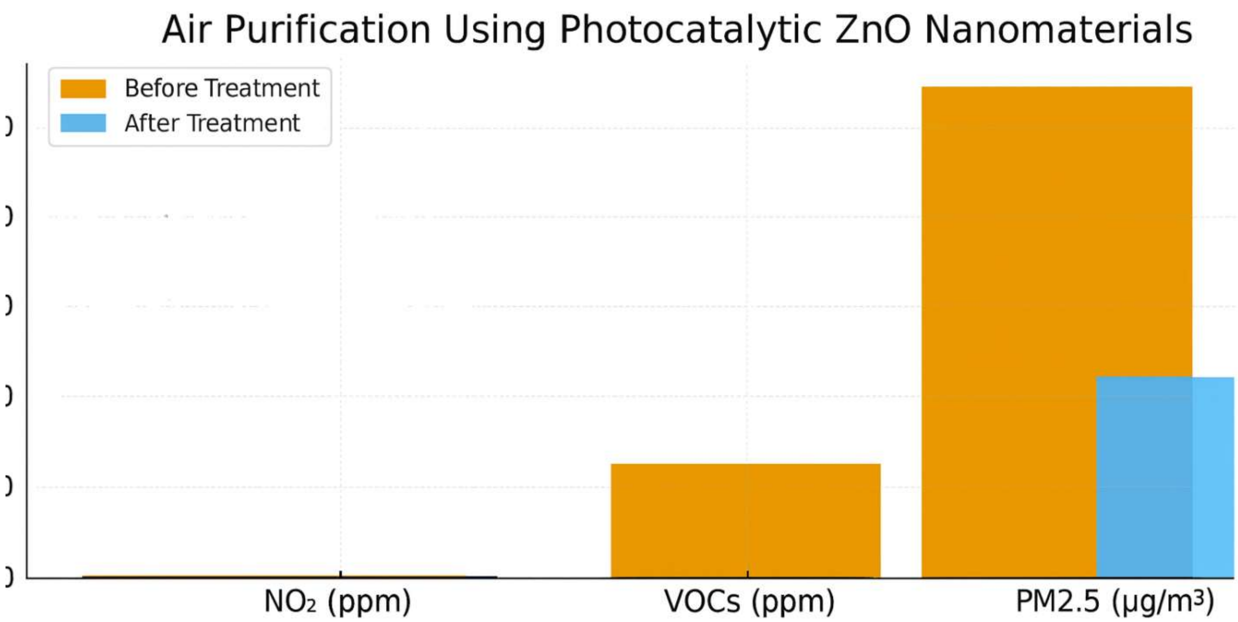
ANALYSIS

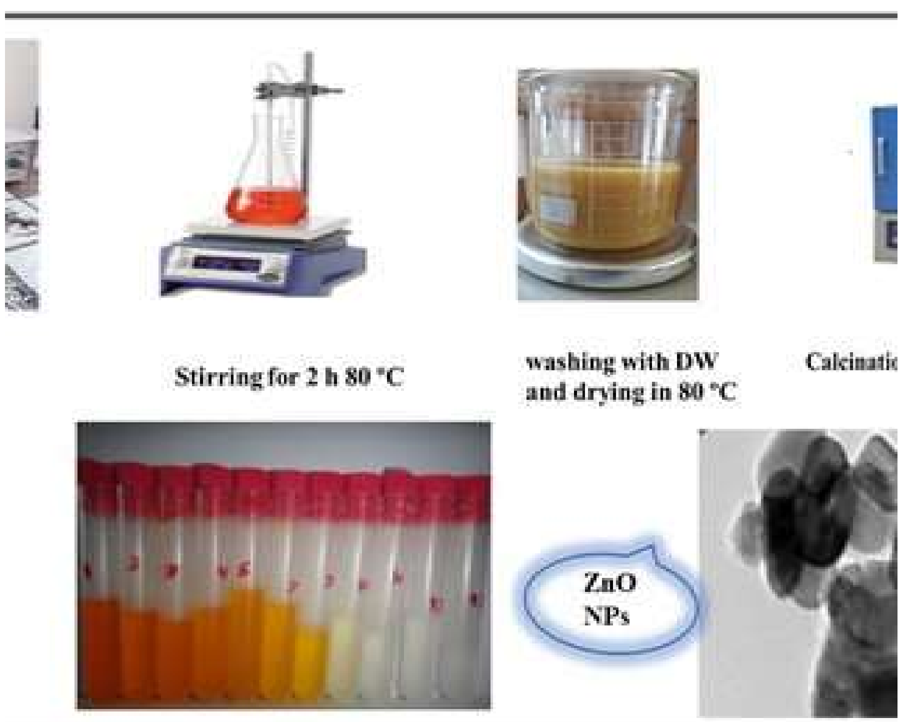
1.Air purifier performance improves with filter upgrades — adding HEPA + Carbon filter consistently lowers PM2.5, VOCs, and CO_2 more than a basic filter.

2. Clean Air Delivery Rate (CADR) increases with stronger filters, showing higher air-cleaning efficiency.

3.Noise level rises slightly with better filtration, but overall air quality improvement is significant.

BAR GRAPH


Air Purification Using Photocatalytic ZnO Nanomaterials
Before Treatment
After Treatment
NO₂ (ppm)
VOCs (ppm)
PM2.5 (μg/m³)


Stirring for 2 h 80 °C
washing with DW
and drying in 80 °C
ZnO
NPs

RESULT

After exposure to light, the ZnO-coated surface shows noticeable air purification effects — reduction in odor and discoloration of air contaminants. The uncoated control surface does not show similar results. This confirms that ZnO nanomaterials exhibit photocatalytic properties that can purify air effectively under light.

CONCLUSION

The experiment demonstrates that zinc oxide nano materials can decompose air pollutants through photocatalytic oxidation. This property makes ZnO a promising material for sustainable air purification systems. The hypothesis is thus verified — ZnO-coated surfaces purify air effectively when exposed to light.

APPLICATION

- Self-cleaning and air-purifying building walls and windows
- Coating on air filters and ventilation systems
- Indoor air purification in hospitals, schools, and laboratories
- Photocatalytic masks and filters for personal protection
- Reduction of urban smog and harmful gases

FUTURE ENHACEMENT:

- Using doped ZnO nanomaterials (like Ag/ZnO or TiO_2–ZnO composites) for higher efficiency.
- Testing performance under different light sources, including visible light.
- Developing reusable and durable photocatalytic coatings.
- Scaling up the design for air purifier prototypes.
- Measuring pollutant reduction quantitatively using sensors or detectors.