

# Enhanced organophosphate sensing response of thermally diffused copper incorporated ZnO nanowires

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## ABSTRACT

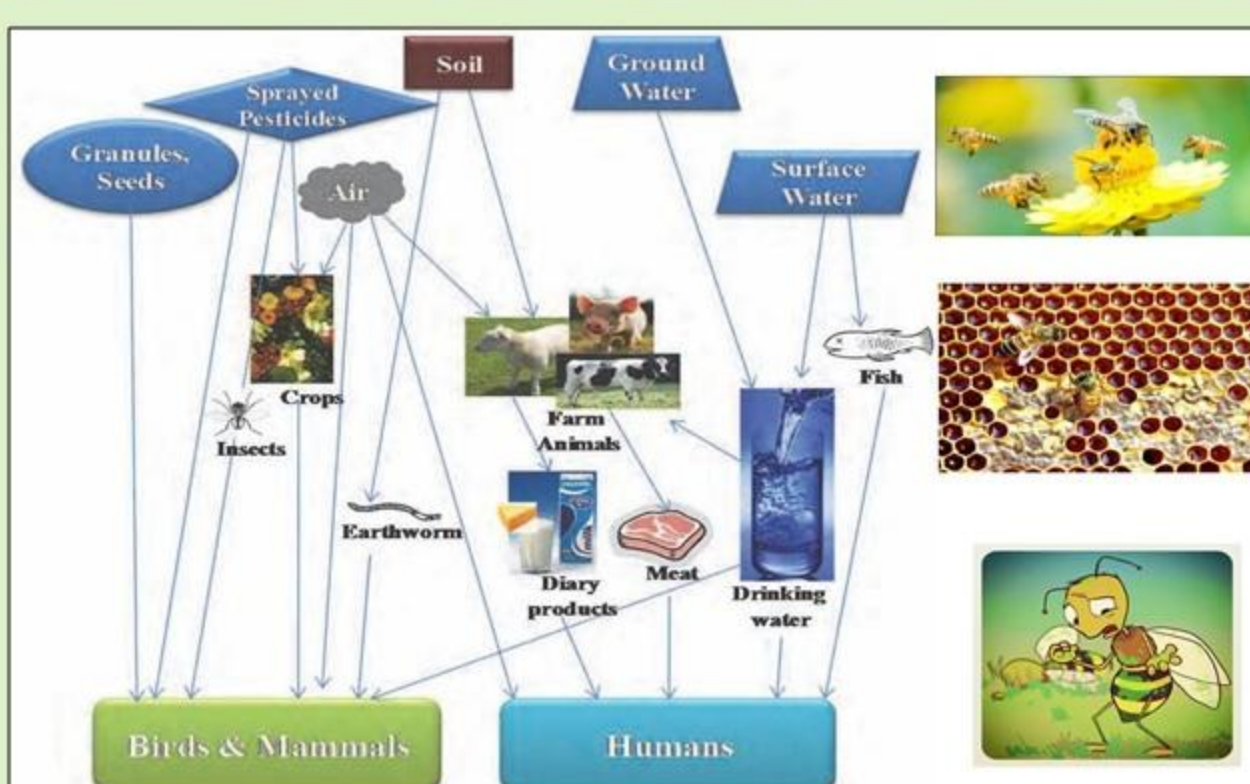
Organophosphate (OP) based pesticides are continuously used above their lethal dosage for enhancement of the agricultural harvest. Consequently, the residues of these toxic pesticides in environment cause several chronic diseases and leads to an ultimate death in living entities. Therefore, real-time detection of these pesticides is very much essential to reduce the environmental health hazards. Thus, an effort has been made to improve the sensing behavior of aqueous grown ZnO nanowires (NWs) by thermal diffusion of RF sputtered Cu atoms in ZnO NWs by annealing at various temperatures in argon ambient. FESEM images have depicted the randomly oriented high density ZnO NWs for the annealed samples. XRD patterns for both thermally diffused Cu-doped and as-grown ZnO NWs have indicated the presence of c-axis oriented single crystalline (002) peak, which is found to be consistent with the high resolution transmission electron microscopy (HRTEM) and selected area diffraction pattern (SAED) results. Micro-Raman spectroscopy has shown E2 modes at about  $96\text{ cm}^{-1}$  and  $437\text{ cm}^{-1}$ , which corresponds to the wurtzite structure of ZnO. Photoluminescence spectra have shown the appearance of strong peaks at 3.35 eV and 2.75 eV. OP sensing response at room temperature have shown significant enrichment in the conductivity with a faster response time ( $<1\text{ sec}$ ) in Cu-doped ZnO NWs.

## Introduction

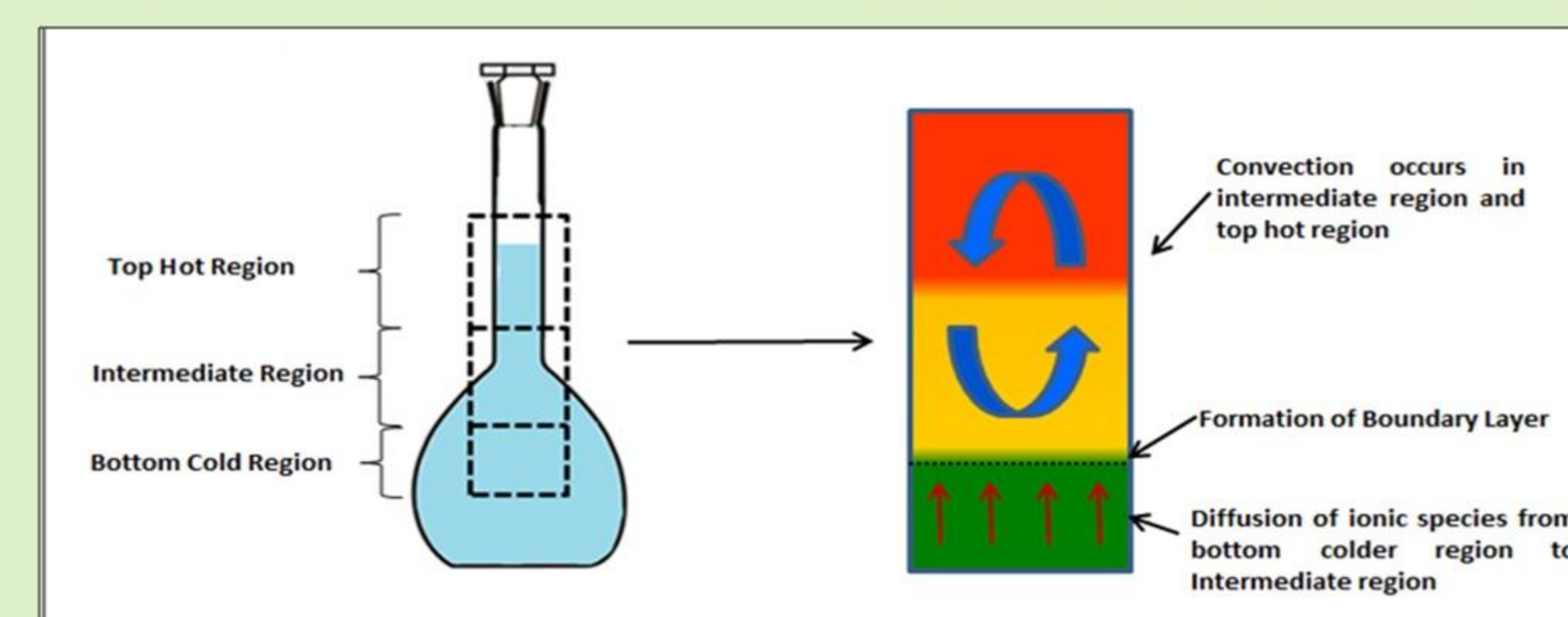
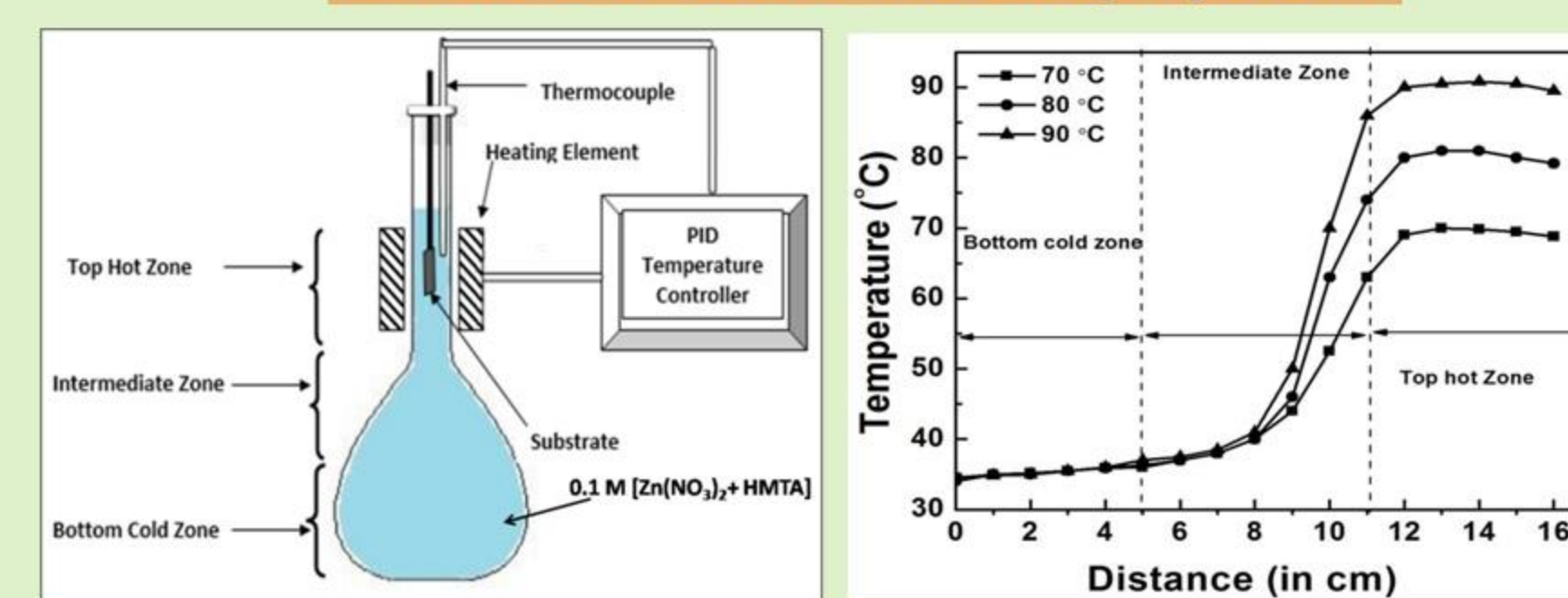
- Organophosphorous pesticides are used for controlling pests worldwide, dominantly in agricultural along with domestic and industrial purpose as well.
- WHO has grouped the OPs in one of the most hazardous pesticide so it is clear indication about its toxicity, and its lethal effect on living entities exposed to it directly or indirectly.
- The OP sensing characteristics is not well explored for different ZnO nanowires
- There is a need of real time portable sensors, where the sensitivity can be recorded by variation in current-voltage behavior.

Maharashtra: 20 farmers in Yavatmal die due to pesticide poisoning, more than 700 in hospital

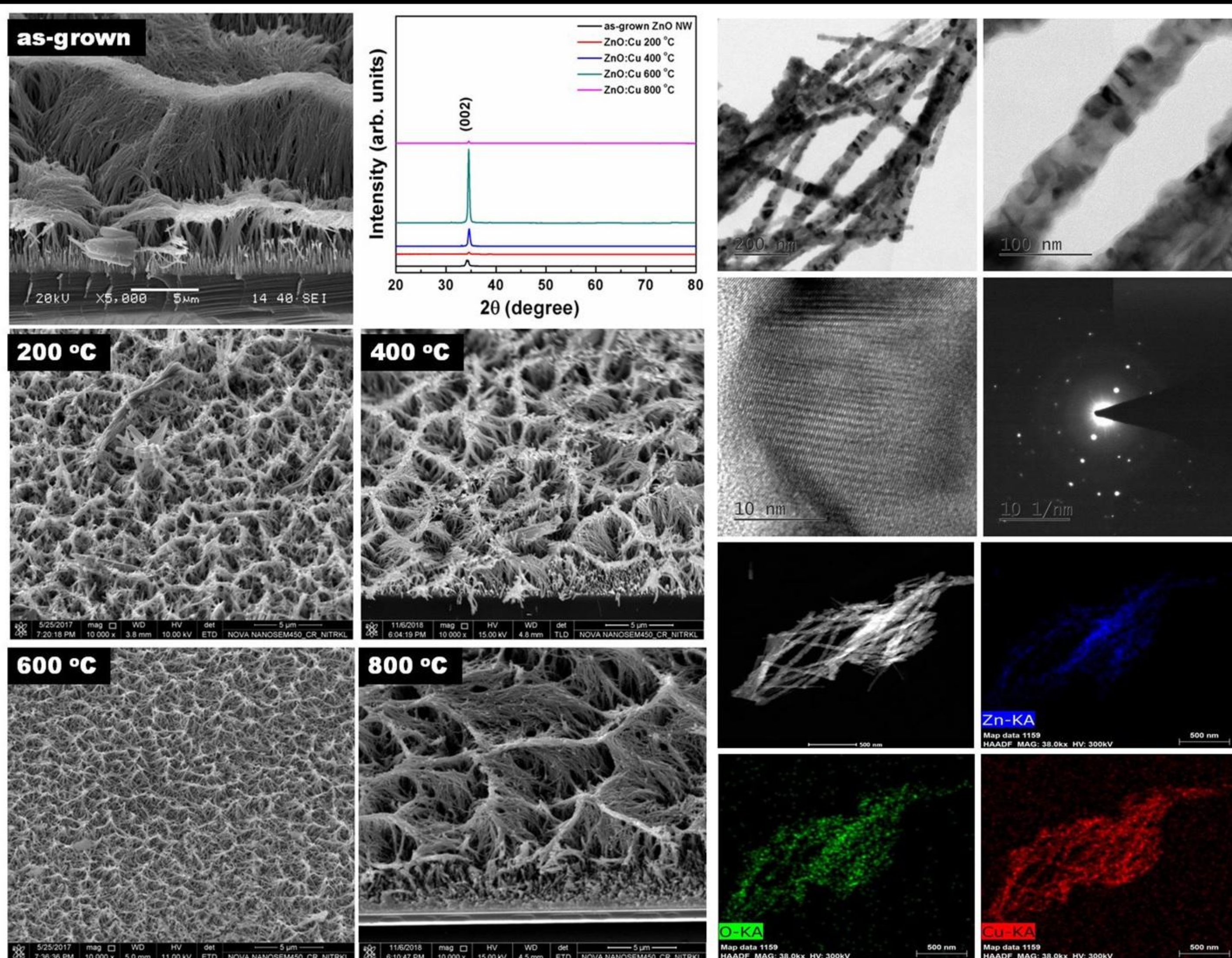
www.timesofindia.com



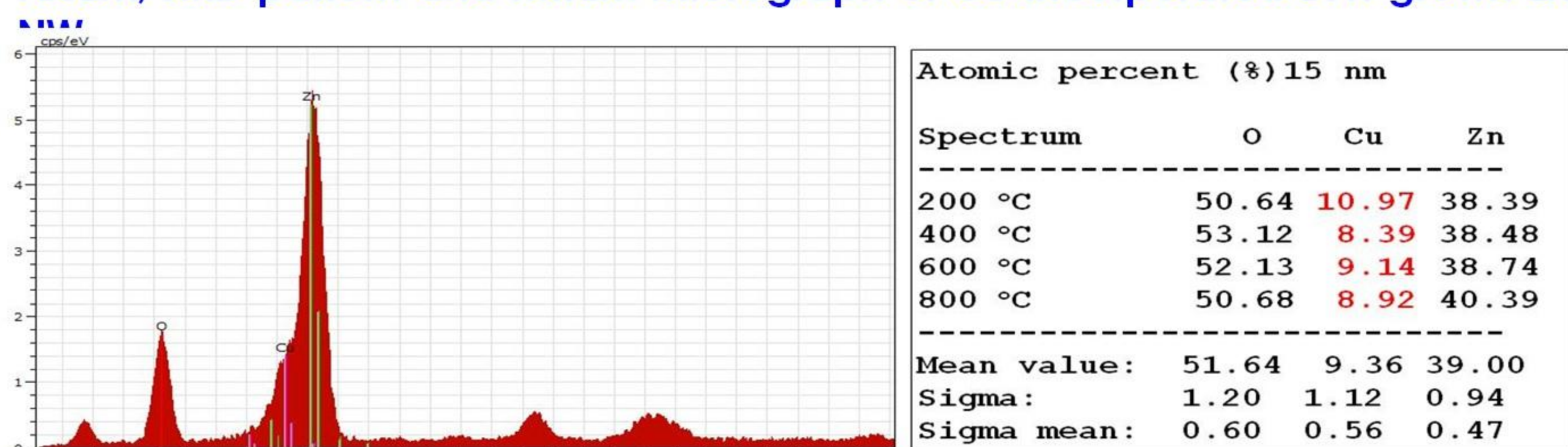
## Limited Volume Heating System



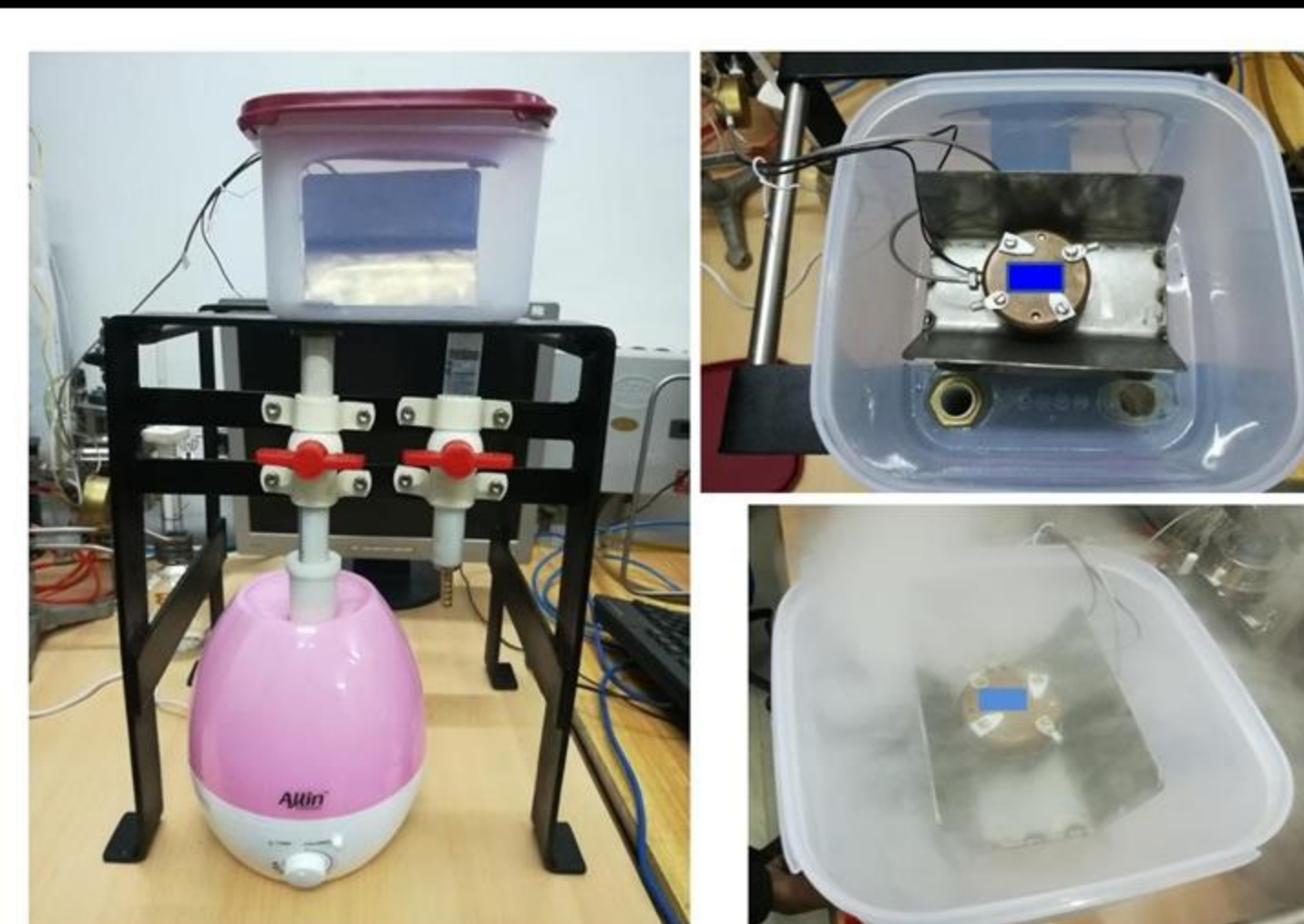
Growth Model for the synthesized nanowires by LVH system



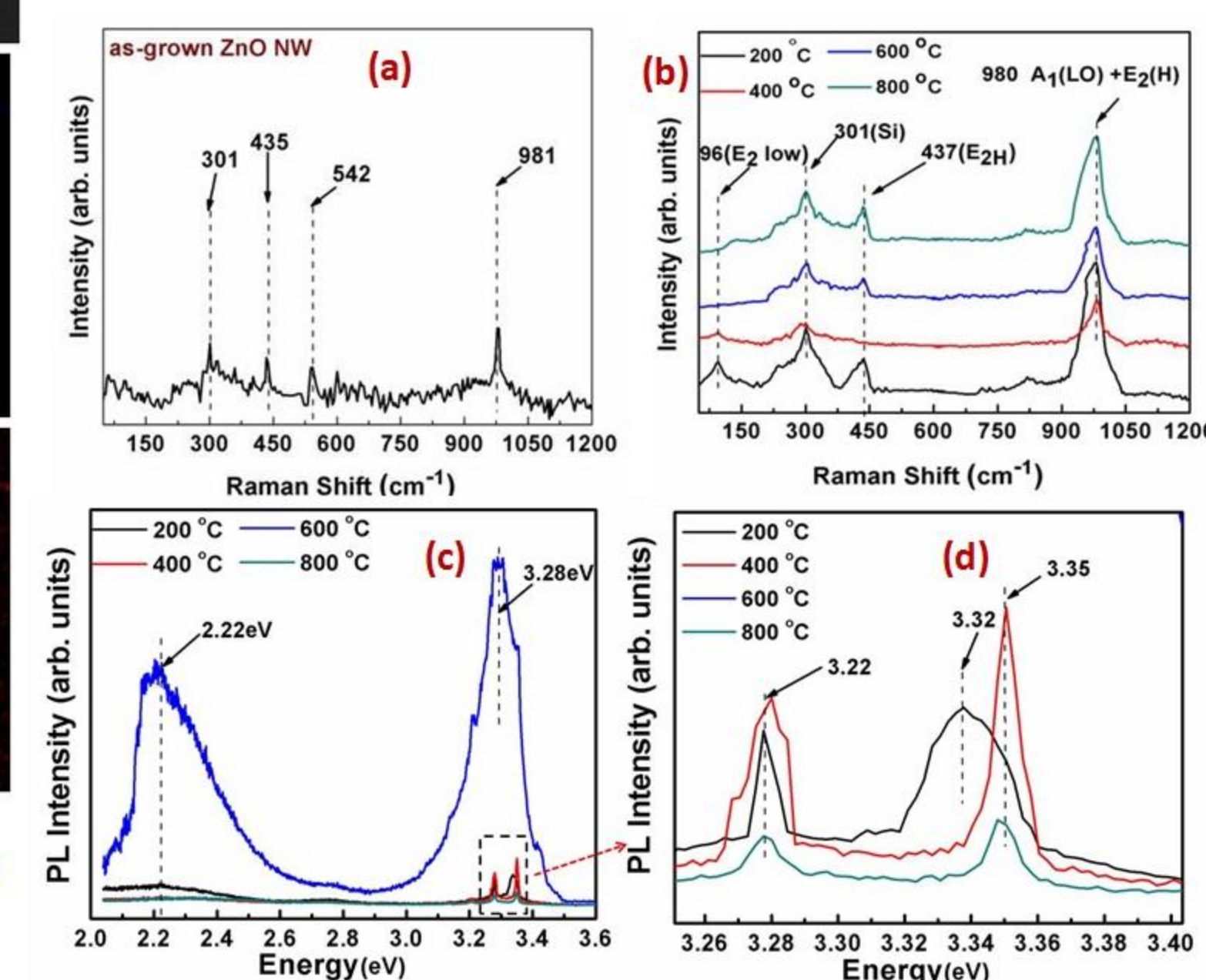
FESEM, XRD pattern and HRTEM micrograph of Cu-incorporated LVH grown ZnO



EDS spectrum and mapping images of Cu-incorporated LVH grown ZnO NW

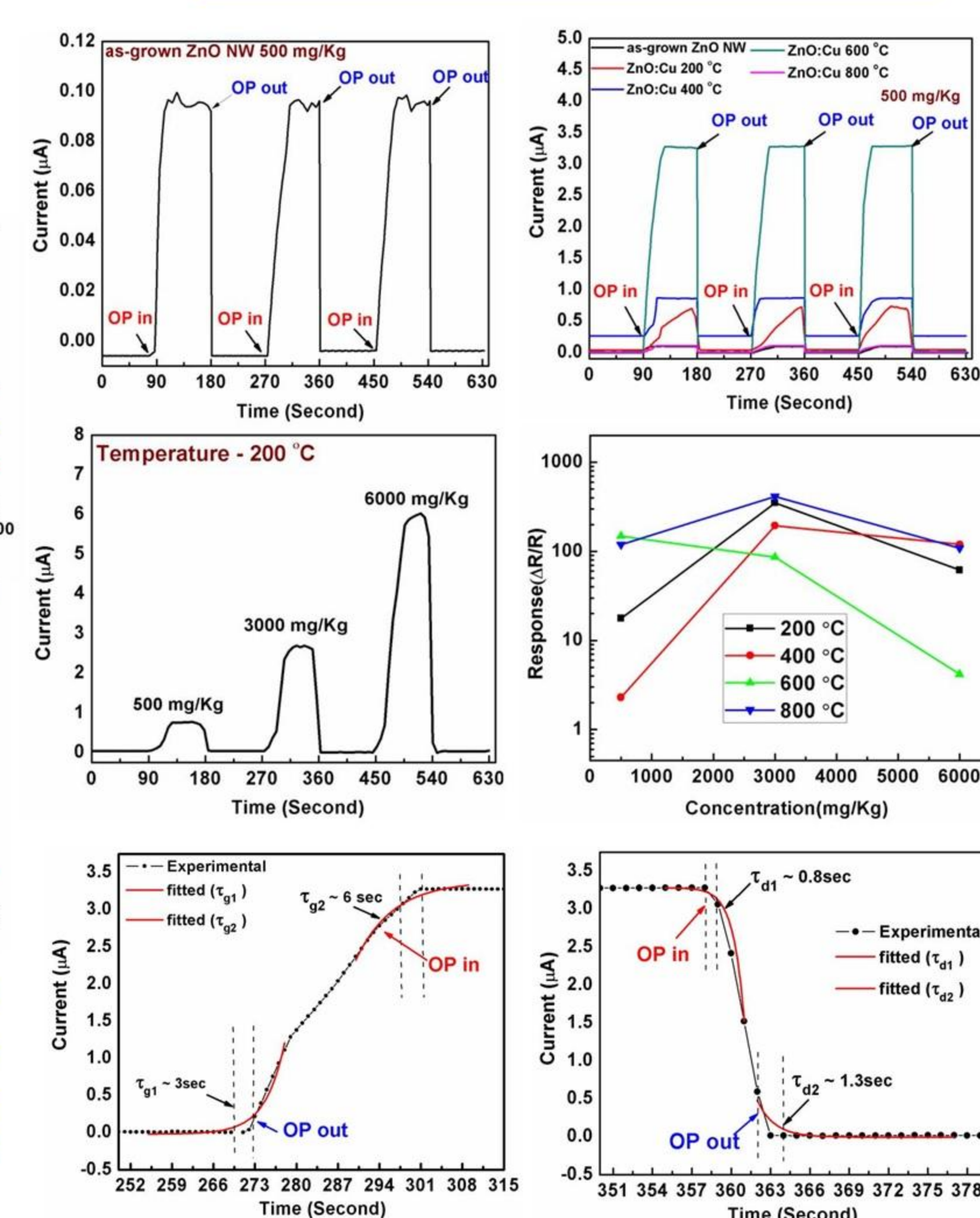


Chemical sensing Chamber



Micro-Raman spectra (a) as-grown ZnO NW, (b) Cu-incorporated ZnO NWs thermally annealed at various temperature in argon ambient under an excitation wavelength of 633 nm,

(c) & (d) PL spectra of Cu-incorporated ZnO NWs annealed at various temperature in argon ambient under an excitation wavelength of 355 nm.



Sensing response of as-grown and Cu-incorporated ZnO NWs annealed at various temperature for different dosage of pesticide

## Summary

- Cu dopant is incorporated into the ZnO host lattice structure without any distortion in morphology and the crystallinity.
- Cu-sputtered nanowires are randomly oriented and of very high density having an average length around 1-2  $\mu\text{m}$  and average diameter of around 45-65 nm for all annealed samples.
- TEM micrograph displays that nanowires have uneven surface morphology due to thermally diffused copper atoms. EDS mapping image of nanowires reveals uniform distribution of Cu throughout the ZnO nanowires without altering its morphology.
- Micro-Raman spectroscopy has shown E2 modes at about  $96\text{ cm}^{-1}$  and  $437\text{ cm}^{-1}$ , which corresponds to the wurtzite structure of ZnO. Photoluminescence spectra have shown the appearance of strong peaks at 3.35 eV and 2.75 eV.
- OP sensing response at room temperature have shown significant enrichment in the conductivity around two orders with a faster response time ( $<1\text{ sec}$ ) in Cu-doped ZnO NWs.

## REFERENCES

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