Synthesis, optical and photocatalytic properties of Co/Ni doped ZnO nanoparticles using Solar light illuminations

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ABSTRACT

A simple precipitation-decomposition method to prepared (Co and Ni-doped ZnO Nps) photocatalyst. The photocatalyst were characterized by various techniques such as Power-XRD, TEM, SEM and Optical spectra. The influence of dopants (Co/Ni) content on the optical properties was investigated. It has been found that the (Co/Ni) doping leads to the optical band gap reduction. Pure and (Co/Ni) doped ZnO nanoparticles possess improved photocatalytic activity and stability and reusability of catalyst are promising for potential performance in degradation of methylene blue dye under solar light irradiation.

Key words: Nano particles, dye, catalysis, light.

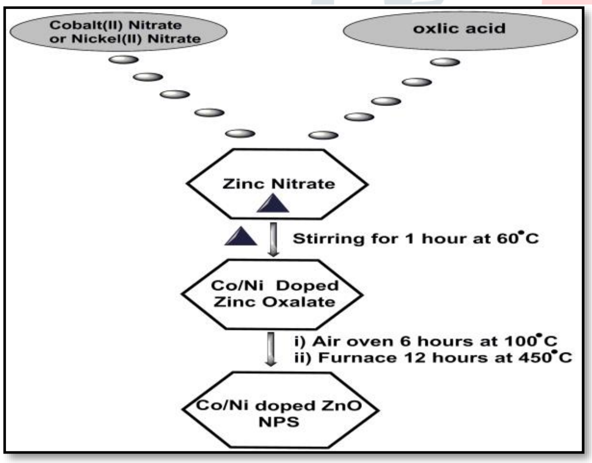
1. INTRODUCTION

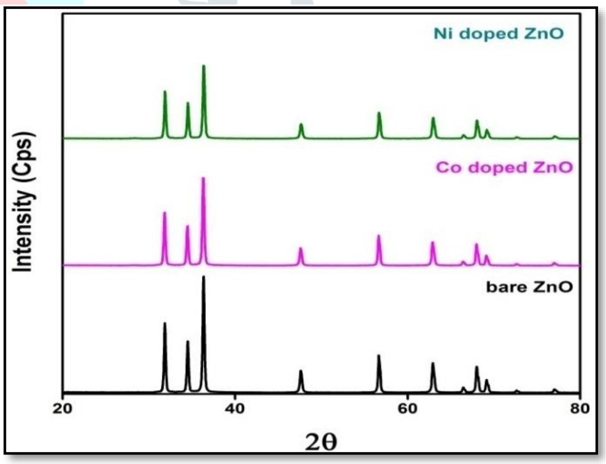
Nanometer-sized particles (1–100 nm) have attracted substantial interest for a large kind of applications, starting from physics via ceramics to catalysts thanks to their distinctive or improved properties, which are primarily determined by size, composition, and structure [1]. These properties square measure powerfully associated with the synthesis processes. Numerous solution techniques, for example, sol–gel, emulsion, colloidal, and aerosol processes, have been used to synthesize a variety of nanoparticles [2–6]. As an alternate approach, the chemical science route is of substantial interest owing to a probably precise particle size management achieved by adjusting current density or applied potential. For chemical science synthesis, in depth investigations are targeted on the metal particles, especially on noble metal particles. This methodology, in fact, skillfully combines associate degree chemical science method with plasma at closepressure and temperature. Compared with alternative strategies of synthesizing metal doped ZnO powder this access has some benefits[7-10].

2. Experimental

2.1. Materials and Methods

All of the Chemicals used in this work were analytical grade reagents and used without further purification. Zinc nitrate, nickel nitrate, cobalt nitrate were purchased from Merck company. Deionized water was used to prepare all solutions. The samples were characterized by X-ray powder diffraction (XRD) using PAnalytical X′ per PRO X-ray diffractometer with Cu Kα radiation. The catalyst morphologies of the Co and Ni doped ZnO nano particles TEM analysis. Optical spectra were prepared via a Shimadzu (2450) spectrophotometer. Photodegradation of dye using solar light illuminations experiments were early discussed [11-12].





Scheme-1 Preparation of bare and Cu/Ag doped ZnO Nanoparticles. Fig. 1 XRD pattern of bare and doped ZnO Nanoparticles.

2.2 Preparation of Co/Ni doped and bare ZnO Nanoparticles.

A Precipitation-decomposition method to prepare catalyst (Scheme-I). A 100 mL of zinc nitrate hexahydrate (0.8 M) and 100 mL of oxalic acid (1.2 M) in triple distilled water used to homogenous was boiled separately. Both are 5 mL of Nickel nitrate (4 % Ni) solution or 5 mL of Cobalt nitrate (4 % Co) solution added slowly one by one with constant stirring of zinc nitrate bulk solution were heated for 1 h at 60–70 °C. Further adding of oxalic acid into bulk solution. Finally precipitation of zinc-Co oxalate occurred when the solution was cooled to room temperature. The zinc-Co oxalate powder washed with triple distilled water and dried at 100 °C for 6 h. The Zinc-Co oxalate powers were calcinated at 10 °C per mints in a muffle furnace reach the decomposition (450°C) temperature. The ZnO–Co/Ni catalyst was collected and used for further analysis.

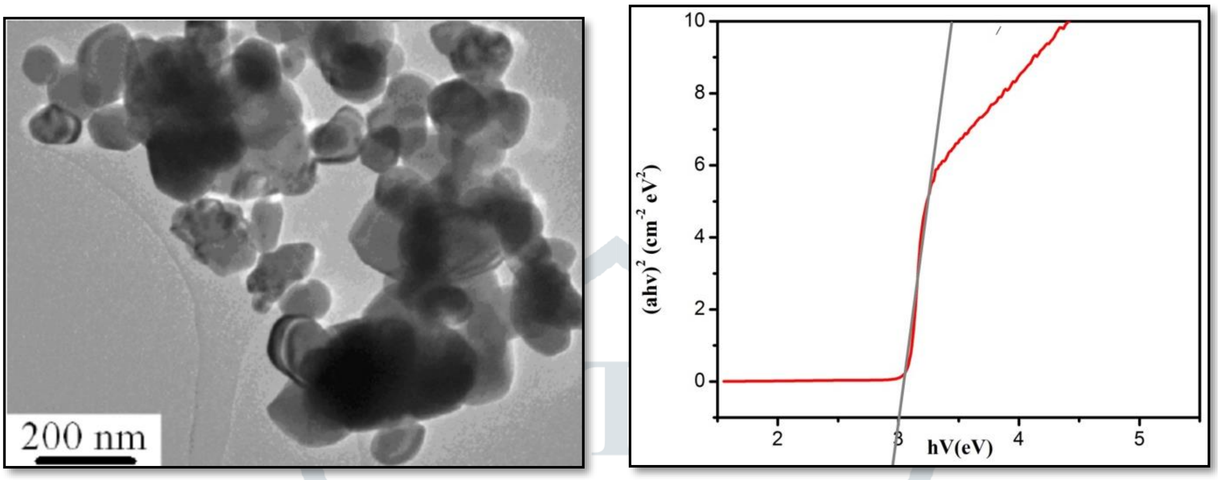


Fig. 2a TEM Image of Co doped Zno Nanoparticles, Fig2b band gap of Ag doped ZnO Nanoparticles

3. Results and Discussion

3.1. Structural and Compositional of catalyst.

X-ray diffraction (XRD) is mainly used for phase identification. Fig.1 shows the XRD pattern of the prepared Co/Ni-doped and undoped ZnO sample. The grown sample shows the peaks of (100) and (101). No signals of the metallic Zn are detected by XRD. Also, there is no peak corresponding with the Co/Ni, suggesting that the Co/Ni element may be doped into ZnO. This pattern reveals that the polycrystalline of hexagonal wurtzite structure that is known ZnO structure. The Bragg angle of the intense (101) reflection is observed as light shift towards higher values relative to that of pure ZnO which has been indicated that Ni-doped ZnO was formed along with NiO phase [11]. It is known that more oxygen content is introduced into the sample. It is clear that the (101) peak is sharper and stronger. TEM image in fig. 2a shows the morphology of Ni doped ZnO particles. It is observed that there is a rough surface in the particles.

3.2. Optical absorption spectra of catalyst

Substation of Co/Ni cations in tetrahedral sites of the wurtzite structure was further conformed by UV–Vis optical spectroscopy[11]. From this figure, the band edge is shifted to the lower energy side of the

Ni doped ZnO samples (fig 4). The decrease in the band edge is a clear indication for the incorporation of Ni inside the ZnO lattice [12].

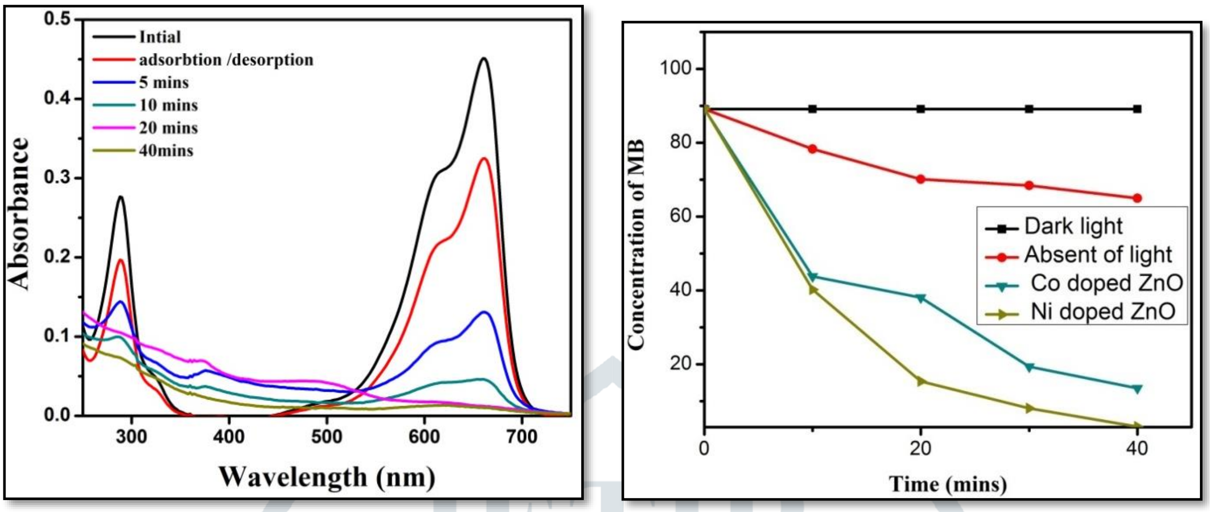
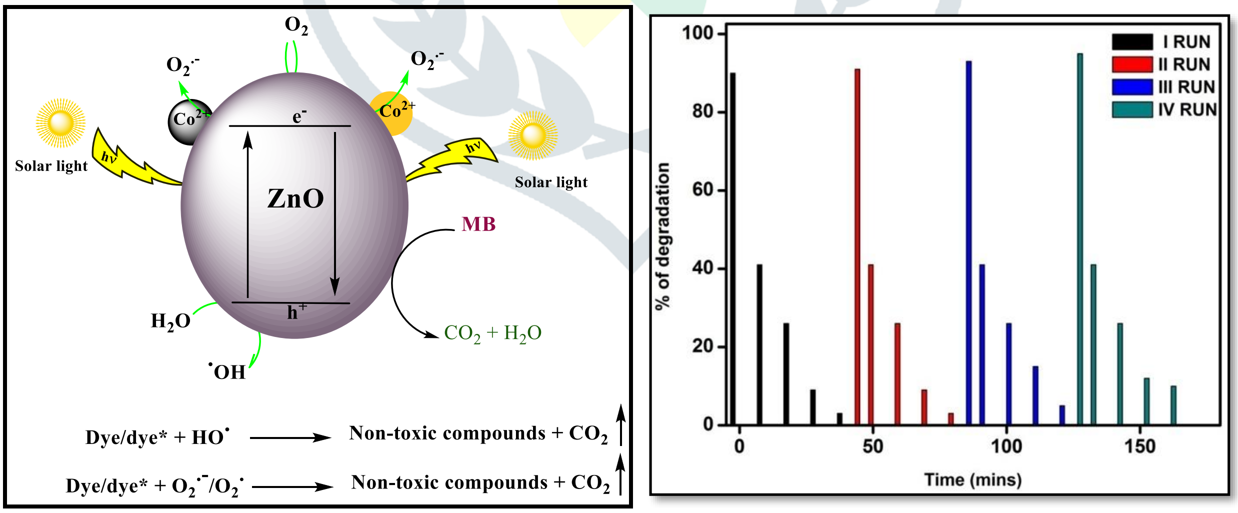


Fig 3. Photodegradation of methylene blue with LEDs light illuminations and different catalysts

The photocatalytic degradation of Methylene Blue (MB) dye by using Cobalt doped ZnO nanoparticles at natural pH (pH= 7) was carried out. Degradation percentage of MB dye sample was carried out using pre fixed amount of cobalt (Co) doped ZnO (4% of Co/Ni) nanoparticles at pH= 7 using photoreactor in presence of solar light source.



.4 Mechanisum of photodegradation of MB in present of Ag doped ZnO nps and catalyst reusable.

3.3 Photo-degradation of MB

The degradation of MB dye increase with increase of solar light irradiation [10,11]. In particular the effect of pH on degradation of dye sample with 100mg of 4% Co doped ZnO photocatalyst is increase with increase of solar irradiation time. For one hour of contact time, the degradation varies from 4% for Co doped ZnO nanoparticles at pH =7 level respectively. Then the percentage removal increases gradually and show maximum of 92% at 40 mins for 4% Ni doped ZnO photocatalyst. Mechanisum of photocatalyst reaction was discussed with solar light illuminations the new Fermi energy level of Co/ZnO is lower than the lowest energy level of the conduction band of ZnO, the photogenerated electrons on the conduction band of ZnOc an transfer to the Co particles. This reduces the charge-recombination between the photogenerated electrons on the conduction band of the ZnO and the photogenerated holes on the valence band of the ZnO. The photocatalyst are reusable for futher dedradation study of MB dye.

4. CONCLUSION

A precipitation-thermal decomposition method for production of Co/Ni−ZnO photocatalyst. HR-TEM images reveal the presence of the hexagonal wurtzite structure of ZnO. The presence of Co/Ni increase the absorption of ZnO to the entire visible region. Ni doped ZnO is found to be more efficient than Co−ZnO, bare ZnO for degradation of MB 120 under solar light at neutral pH. This catalyst was found to be reusable. advantage of catalysis its “simplicity”, “low cost”, “reusability”, and “excellent performance”.

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