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ROUTE TO ANTIBACTERIAL ACTIVITY BY GREEN SYNTHESIS OF ZnO NANOPARTICLES DOPED WITH PETROSELINUM CRISPUM AND PIPER BEETEL

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Abstract: Nanoparticles have wide applications in various fields due to their small size. Under this the plant based nanoparticles has many advantages over conventional physio-chemical methods and has various applications in medicine. In present study the zinc oxide nanoparticles were synthesized using the extracts of petroselinum crispum and piper beetle. 0.01 M zinc acetate dehydrate was used as a precursor in leaf extracts of respective plants for nanoparticles synthesis. The sol-gel route remediation of the zincoxide from the environment is an important step, and it can be achieved by using physical process like sedimentation and filtration. The structural and optical properties were investigated by using X-ray diffraction (XRD) method, Uv-Vis. Morphological analysis by Scanning electron microscope (SEM). The green route of synthesis is rather safe and eco-friendly when compared to chemical route and could be used for the fabrication of Zinc oxide nanoparticles as an antimicrobial agent.

Key words: ZnO nanoparticles, Green synthesis, Sol-gel route, SEM, UV-Vis

I. Introduction

Nanotechnology deals with the production and usage of material with nanoscale dimension. Nanoscale dimension provides nanoparticles a large surface area to volume ratio and thus very specific properties. Zinc oxide nanoparticles (ZnO NPs) had been in recent studies due to its large bandwidth and high exciton binding energy and it has potential applications like antibacterial, antifungal, anti-diabetic, anti-inflammatory, wound healing, antioxidant and optic properties. Due to the large rate of toxic chemicals and extreme environment employed in the physical and chemical production of these NPs, green methods employing the use of plants, fungus, bacteria, and algae have been adopted. Many scientists have concerns about safety because synthetic antioxidants have recently been shown to cause health problems such as liver damage due to their toxicity and carcinogenicity. Therefore, the development of safer antioxidants from natural sources has increased, and plants have been used as a good source of traditional medicines to treat different diseases. Many of these medicinal plants are indeed good sources of phytochemicals that possess d activities. Some typical examples of common ingredients that have been used in ethnic foods are caradammom, lemon grass, parsley , beetel , clove etc., These spices are herbs have been known to contain antioxidants. Herbs have also been used for flavor and fragrance in the food industry and some of them have been found to exhibit antimicrobial properties. Therefore, the call for screening and using plant materials for their antioxidant and antimicrobial properties has increased. Approximately 20 % of all plant species have been tested in both pharmacological and biological applications to confirm their safety and advantage [1].

Plants possess rich genetic variability with respect to number of biomolecules and metabolites and carbohydrates. These plant metabolites contain hydroxyl, carbonyl and amine function groups that react with metal ions and reduces their size into nano range. More specifically flavonoids contain several functional groups and it is believed that –OH groups of flavonoids is mainly considered responsible for the reduction of metal ions into nanoparticles. The molecules not only help in bioreduction of the ions into nanoscale, but they also play a vital role in the capping of the nanoparticles which is important for stability and compatibility. Reducing agents such as phenolic compounds, sterols and alkaloids can reduce metal ions into nanoparticles in a single reaction.

The type and nature of the metal used for nanoparticles biosynthesis mainly determines the nanoparticles and use. Several metals such as silver, copper, gold, Titanium dioxide zinc oxide and many other have been widely used for the biosynthesis of nanoparticles using palnt extracts of various plant species. Zinc oxide (ZnO) is an inorganic compound, which occurs rarely in nature. It is generally found in crystalline form. When purified ZnO appears as white crystalline powder which is nearly insoluble in water [2-4]. Due to their low toxicity and size dependent properties of ZnO nanoparticles have been widely used for various applications in textiles, cosmetics and even in micro-electronics. Because ZnO is generally recognized as safe and exhibits antimicrobial properties, ZnO nanoparticles hold greater potential to treat infectious diseases in humans and animals.

ZnO has found to be potentially useful and efficient than other metals for biosynthesis of nanoparticles. Several studies have demonstrated the synthesis of ZnO nanoparticles using different plant extracts. For example the leaf extracts of petroselinum crispum and piper beetle were used as reducing agents for zinc acatetae dihydrate to synthesis zinc oxide nanoparticles [5-6].

II. Materials and Methods

Young leaves of petroselinum crispum and piper betle were picked in India. All chemical materials used in the experiments were purchased from Sigma Aldrich. Zinc acetate dihydrate and water as a solvent. Around 60g of crushed leaves were added to 50 ml of water and left for 24 h , after which the mixture was heated and stirred at 45^0C for 2 h, and the plant extract was filtered with Whatman No.1 filter paper twice. The filtrate was collected and kept at 4^0C. This prepared extract was directly used in the synthesis experiments [7-8]. 1 M zinc acetate dehydrate was dissolved in 20 ml of water and kept under continuous stirring for 30 min. Approximately 2 mL of extract (as a natural surfactant) was added to the solution, followed by stirring for 2 h at 80 ^{0}C; the suspension was centrifuged and precipitate was dried at 60 ^{0}C in a hot air oven until dried nanoparticles were obtained. The prepared nanoparticles were calcined at 500 ^{0}C for 2 h.

III. Results and Discussion

Fig.1. shows the XRD pattern of pure Zincoxide nanoparticles for as prepared and annealed sample at 500^0C with crystal structure as the wurzite phase of ZnO nanoparticles. Fig.2. represents the XRD pattern of Doped ZnO nanoparticles annealed at 500 ^{0} C. It was observed that there is a constant intensification in the intensity of doped samples. There is a change in the peak position at lower 2θ values with the different dopants [8-9]. The average crystalline size was found to about 3.76 nm, 2.9721 nm and 2.8914 for pure ZnO and doped with petroselinum crispum and ZnO doped with piper beetel. Which was estimated from the Debye-Scherrer equation given by

$$D = \frac{K\lambda}{\beta cos\,\theta}$$

Where, β= FWHM, θ= Bragg angle, K=0.9 & λ= 1.54 Ǻ (x-ray wavelength)

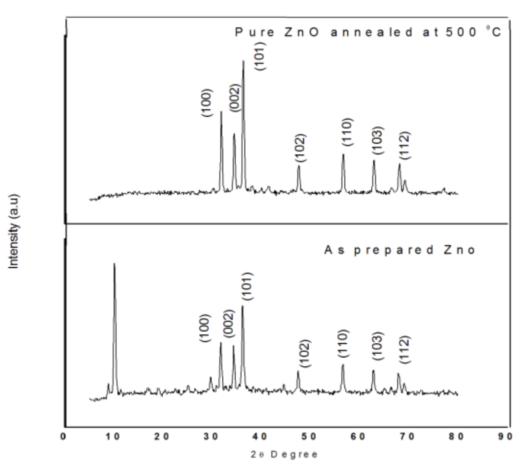

Fig.1 Pure ZnO nanoparticles of as prepared sample and annealed at 500 ^{0}C

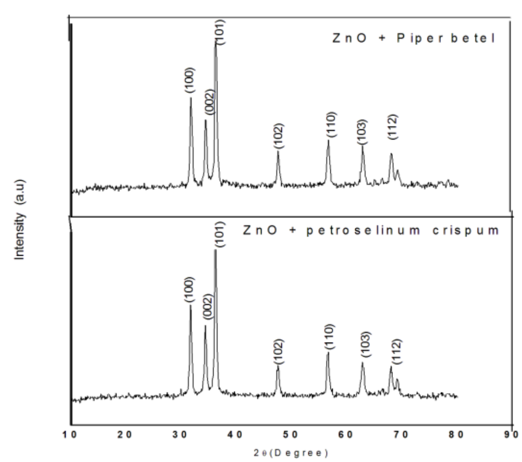

Fig.2 Doped ZnO nanoparticles annealed at 500 ^{0}C

Optical analysis of pure and doped samples annealed at 500^0C is shown in Fig. 3 (a,b& c) respectively. Temperature is considered as an important contributing factor in synthesized good sized nanoparticles. It is also well established that higher the temperature of reaction process and annealing the smaller the size of the nanoparticles. Therefore we use a relatively higher temperature for incubating the reactants that leads to the production of very small sized ZnO nanoparticles. Whereas the absorbance of the samples were recorded at 369 nm, 367 nm and 369 nm for pure and patroselinum crispum doped and piper beetel doped zincoxide nanoparticles [9-10]. The results satisfy the standard ZnO nanoparticles absorption pattern because all oxide materials have wide band gaps and to have shorter wavelengths.

The band gap analysis of Zno and doped nanoparticles given in Fig 4.a, b and c. The band gap values of the samples were 3.38 ev, 3.75 ev and 3.9 ev , it reflects that as the particle size decreases the band gap increases and it satisfies too [11-13].

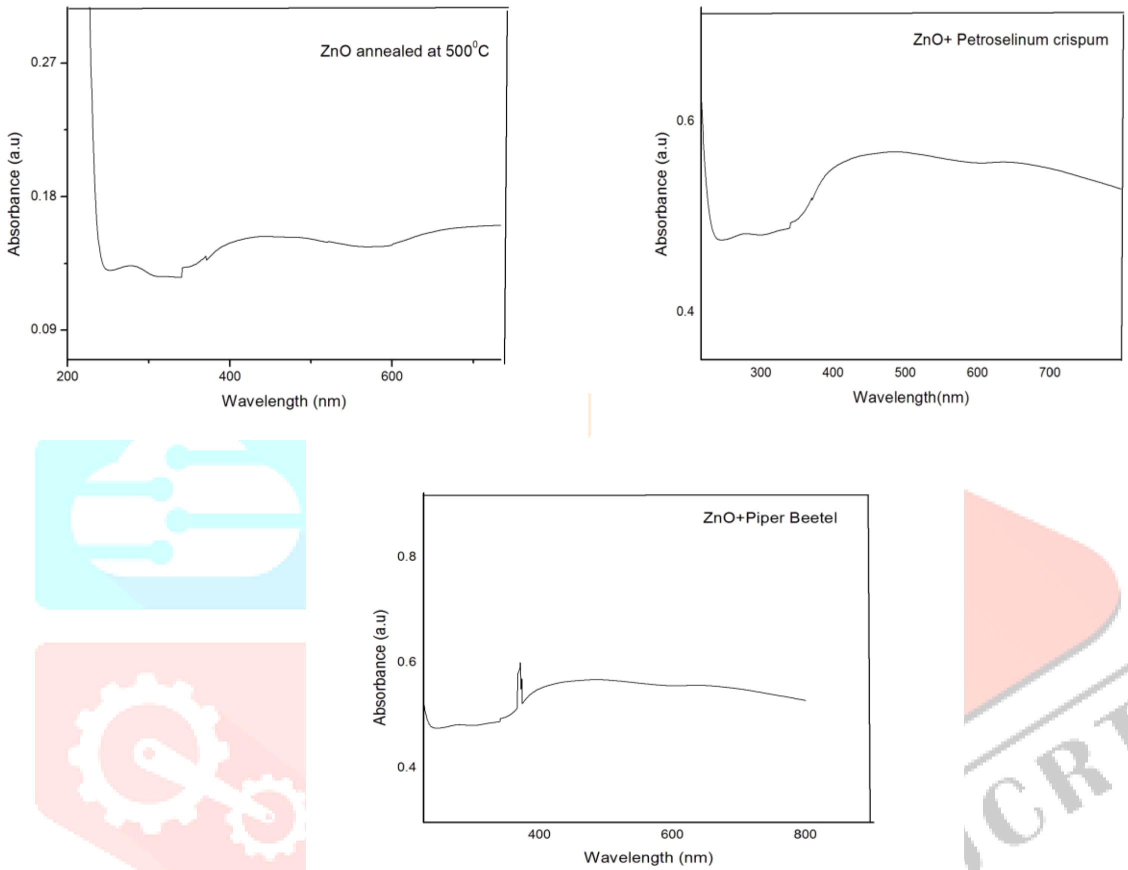

Fig .3. a, b & c of aborbace spectra for samples pure and doped ZnO nanoparticles at 500^0C

Fig. 5, a. b & c shows the compositional analysis of pure ZnO, petroselinum doped ZnO and piper beetel doped ZnO nanoparticles by EDAX Spectrum[13].

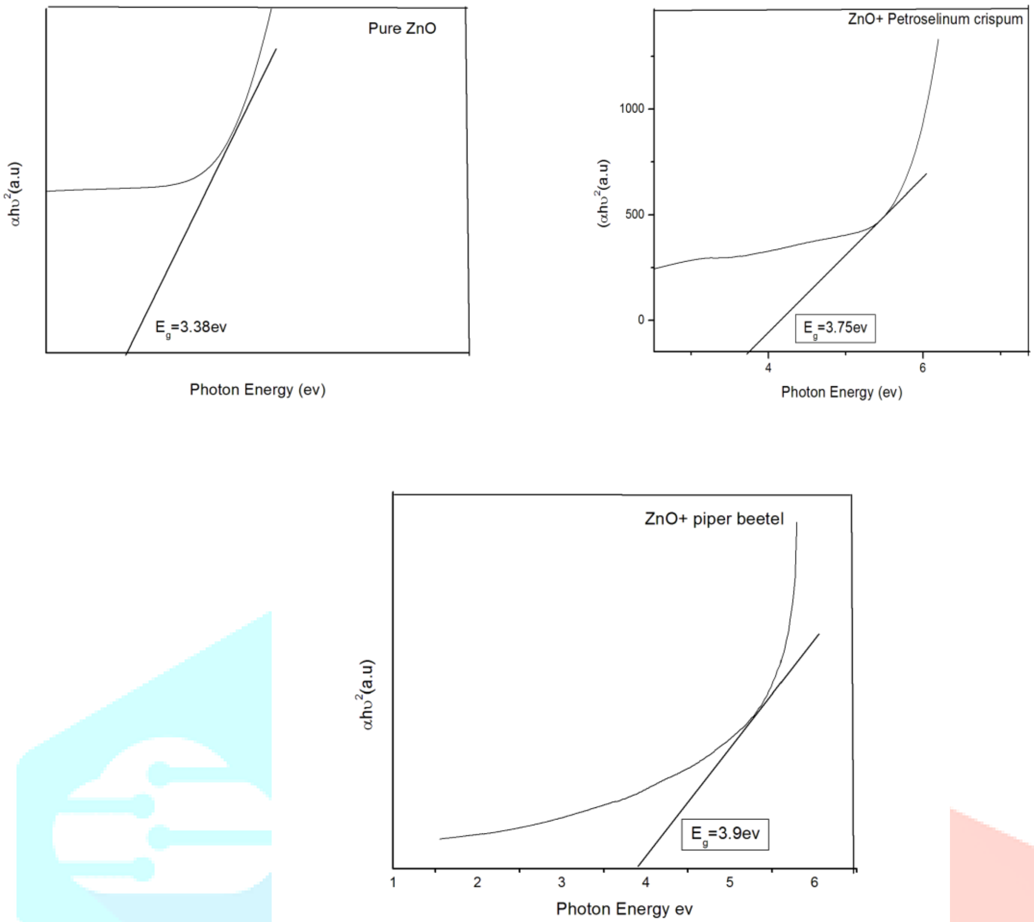

Fig .4 a, b & c of bandgap for samples pure and doped ZnO nanoparticles at 500^0C

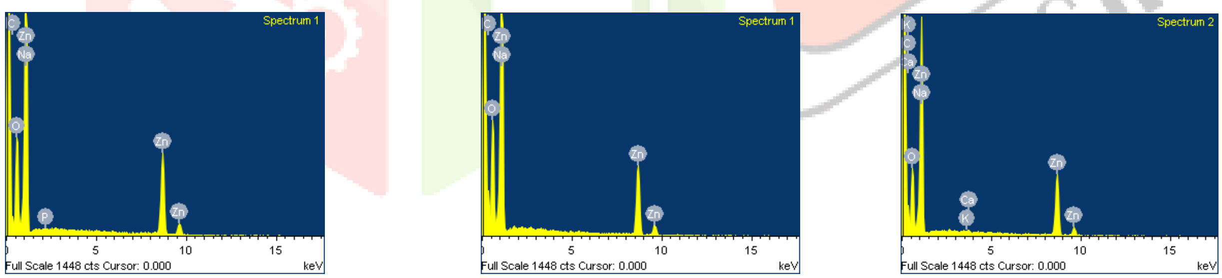

Fig .5 a, b & c EDAX analysis of samples pure and doped ZnO nanoparticles at 500^0C

The Fig.6. a, b& c shows the SEM images of pure ZnO, petroselinum doped ZnO and piper beetel doped ZnO nanoparticles. The images were recorded and the topographical view shows that nanoparticles are more or less spherical in nature, cluster together and surface of the aggregate sems to be rough. It was revealed that the green synthesized dopants has also have a capability to synthesize ZnOnanoparticles [14]. Shape of ZnO nanoparticles plays crucial role in the effectivity against pathogens.Because spherical nanoparticles tend to be very potent during antibacterial activity to their ability to easily penetrate into cell wall of pathogens, therefore ZnO nanoparticles synthesized from two plant species can be of great importance in treating clinical pathogens [15-16].

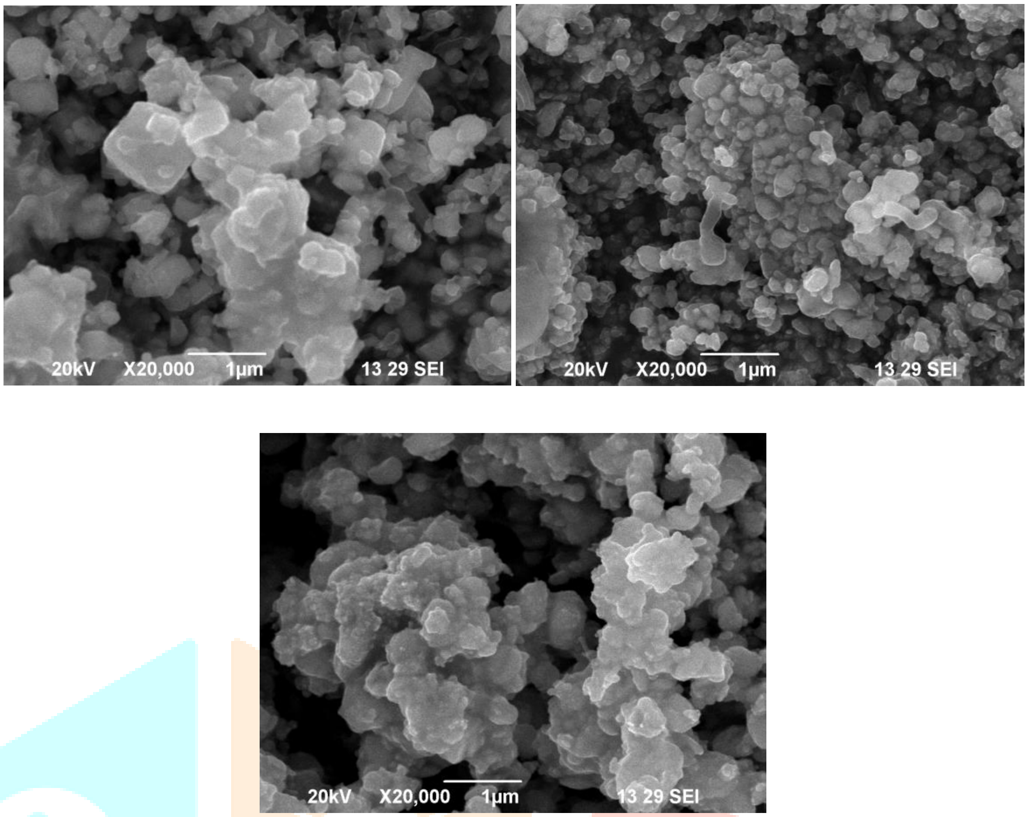

Fig .6 a, b & c SEM image of samples pure and doped ZnO nanaparticles at 500^{0}C

Conclusion

The current study explores the possibility of utilizing the pure and green synthesized doped zincoxide. The nanoparticles were studied and the results revealed that the decrease in particle made the band gap to increase from 3.38 ev to 3.9 ev. Also the compositional analysis shows the presence of compounds appropriately. The particle size of the samples and the microstructure of the samples influences in the study of antibacterial activity and photo degradation in future.

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