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Properties of certain Herbicides in Aqueous solution: A case study of Phyto Catalytic Decontamination

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ABSTRACT

Photo-catalysts are referred to as those solids which participate in reactions in the presence of light and are not consumed in the whole reaction. It is necessary to generate OH radicals that the redox potential of valence bond hole must be in positive state. On the other hand, to minimize the absorbed oxygen to super oxide, the redox potential of photo generated conductance band electron must be negative.

The activation of photon absorbing species is done in hetro geneous catalysis and the process is speed up with the help of the interaction through an excitation state. The electron pairs are generated as a result of interaction of photons. The current article highlights the phyto catalytic decontamination.

INTRODUCTION

Since catalysts are used as semiconductor in the process therefore the transfer of the excited electrons to the reducible specimen when an electron is accepted by the catalyst. In both the situations, the flow of electron is found to be null and the catalysts remains the unchanged.

It is observed that the electrons get promoted from the valence band to the conductance band when photons having a certain wavelength are incident on its surface. As a result of this, positive holes are generated in the valence band which further reacts with the surface giving OH radicals.

In some cases, it is found that the stored energy is released in the absence of appropriate electron. The recombination of electrons is avoided if a surface defect state is there to store the electron.

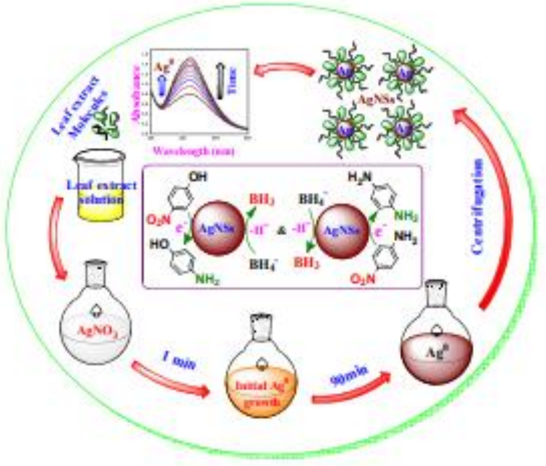
Sulfonylurea is considered to have low application rate and toxicity. Sulfonylurea herbicides are water soluble and it is found that in some cases, they have higher resistance in alkaline soils.

The hydrolysis of Sulfonylurea herbicides in aqueous solution is performed at a rate that is a function of temperature and pH. With the variation in the molecule's structural feature, the rate of hydrolysis also tends to variate.

Some of the advantages of the photo catalytic process are that it takes place at normal temperature. Also, all the substances are oxidized to carbon dioxide. The required oxygen for the reaction is easily obtained from the surrounding environment. The main benefit of using catalyst is that it can be used again and again in several reactions.

METHODOLOGY

In a typical experiment, 1.8 mL of 4-HNB (0.1 mM, aqueous solution) was mixed with 0.7 mL of NaBH4 (0.01 M aqueous solution) in a quartz cell (3.0 mL). Then, 0.01mg of Ag-NSs catalyst was added to the mixture of 4-HNB and NaBH4 and the changes in the absorbance of the solution were monitored with a UV-visible spectrophotometer at different time intervals. After the reaction was over, the mixture was centrifuged and washed with deionized water thrice. The resulting catalyst was reused in the next reaction. 4-NPA was also detoxificated by adopting the same procedure.



Scheme 1. Synthesis of Ag-NSs using SGLE and its catalytic performance in the decontamination of 4-HNB and 4-NPA.

RESULTS AND DISCUSSION

Since green synthesized Ag-NSs exhibit strong absorption band due to SPR in the visible region at about 400 to 480 nm, the electronic spectroscopy is one of the simplest techniques to characterize them. The formation of Ag-NSs was visually identified by means of change in color of reaction mixture from pale yellow to yellowish brown to dark brown, depending on the intensity and hence the number of nanospheres.

UV–visible absorbance spectral values at 420 nm confirm the bioreduction of silver ions to metallic silver (Fig.1b (curve a-j)) by using SGLE. The SPR peak appears immediately after the addition of the plant extract. The formation of Ag-NSs with different time intervals of 1, 10, 20, 30, 40, 50, 60, 70, 80 and 90 min indicate that there is no shift in the absorption peak position. Only SPR intensity increases, which indicates the continuous reduction of the silver ions and the increase in absorbance signifies the formation of uniform Ag-NSs.

In the synthesis of metal nanoparticles using plant extract, the reaction time is a major drawback for several biosynthetic procedures.36 But here the absorption peak steadily increases and after 90 min there is no increase, which confirms that the reaction is completed within 90 min.

The absorption recorded after 24h shows the same intensity, which is shown in Fig. 1d. The observed SPR band at 420 nm is a strong evidence for the successful formation of Ag-NSs. Scheme 1 shows the detailed mechanism of green synthesized uniform Ag-NSs and its catalytic performance in the reduction of 4-HNB and 4-NPA.

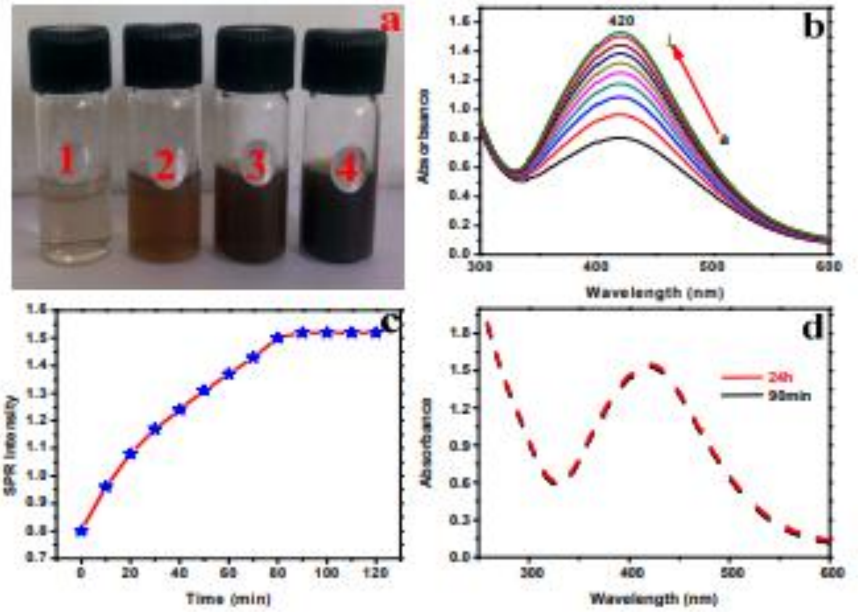


Fig. 1 (a) shows the photographs of Ag-NSs at different time intervals (1) leaf extract only, (2) having added $AgNO_3$ after 10 min, (3) 50 min and (4) 90 min; (b) UV –Visible spectra of Ag-NSs as a function of time with time interval of 10 min. (curve a to j); (c) Plot of the intensity of the SPR at 420 nm against the reaction time; (d) UV –Visible spectra of Ag-NSs after 90min (black line) and after 24h (red line).

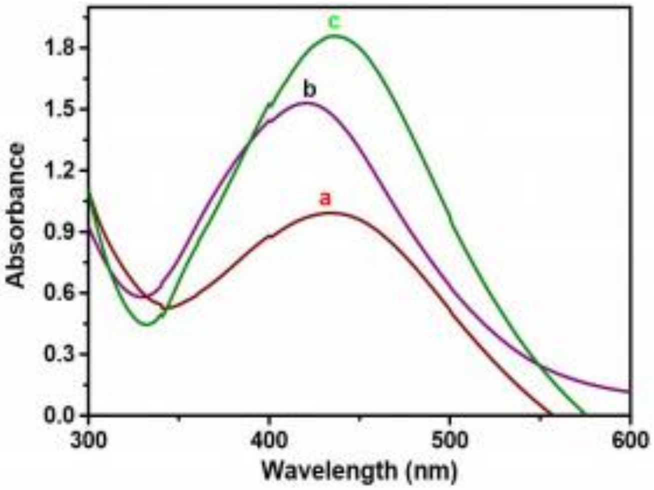


Fig. 2 UV-Visible spectra with different concentrations of $AgNO_3$ (a) 0.05, (b) 1.0 and (c) 1.5 mM.

The peak at 660 cm -1 is the plane bending vibration of N–H groups in the proteins. The strength and intensity of the all peaks are obviously weakened. After reduction with silver ions (Fig. 3b, c and d) the strength of the peak at 3409 cm-1 represents the presence of proteins/enzymes or polysaccharide components and assigned to the vibration of –N–N– groups, the stretching vibrations of methyl groups or C=H stretching vibrations of aldehydic amine groups are observed at 2925 and 2850 cm-1 and the peak at 660 cm-1 indicates the reduction of the silver ions coupled to the oxidation of the amine components.

Meanwhile the intensity of the above mentioned hydrogen bonded N–H groups weakens obviously. The observed results indicate the possible involvement of above mentioned groups in the Ag-NSs. The peak at 1622 cm-1 is due to C=O stretching vibration of carbonyl and carboxylic groups present in amide-I linkage of proteins.

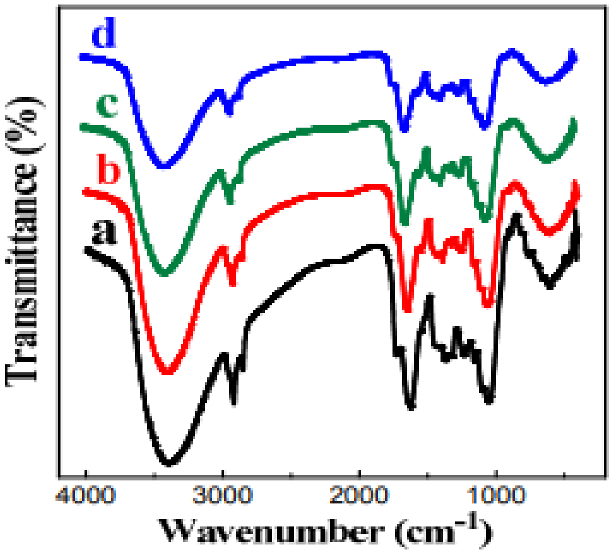


Fig. 3 FT-IR spectra of SGL (a), having added $AgNO_3$ to SGLE after 10 min (b), 50 min (c) and 90 min (d).

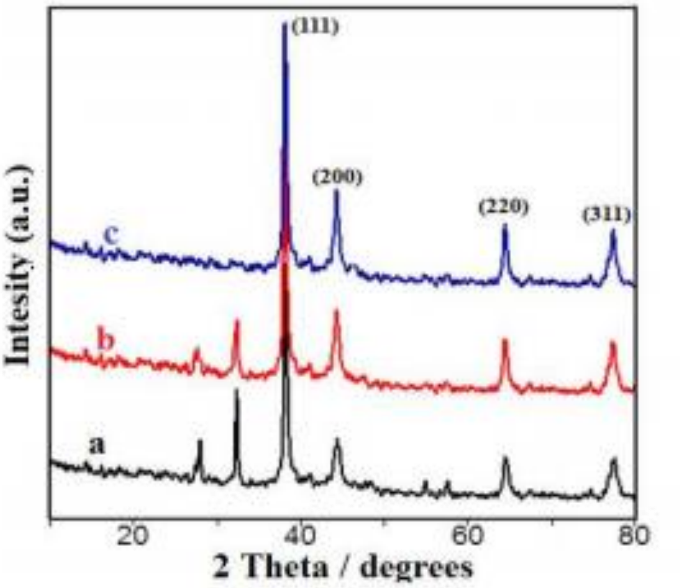


Fig. 4 XRD Patterns of Ag-NSs synthesized at different time intervals (a) 10 min, (b) 50 min and (c) 90 min.

CONCLUSIONS

In summary, a simple green synthesis and characterization of AgNSs for the decontamination of 4-HNB and 4-NPA have been demonstrated. The formed Ag-NSs is uniform in size of 7nm. The value of rate constant, k for reduction is calculated to be, for 4- HNB: 18.424×10^{-3} S^{-1} and for 4-NPA: 6.425×10^{-3} S^{-1} at room temperature. The catalyst exhibits high activity for the conversion even after five cycles. The synthesized Ag-NSs as green catalyst with high reusability is very efficient, stable and cost-effective for the decontamination of hazardous pollutants.

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