A nanocomposite of silver nanoparticles and carbon nanospheres for photocatalytic degradation of methylene blue under UV irradiation

Md. Akherul Islam[1], Md. Abu Hanif[1], Kamal Prasad Sapkota[2], Jeasmin Akter[2], Hafiz Ghulam Abbas[3], Jae Ryang Hahn[1,2,4*]

[1]*Department of Bioactive Material Sciences, Jeonbuk National University, Jeonju 54896, Korea*
[2]*Department of Chemistry and Research Institute of Physics and Chemistry, Jeonbuk National University, Jeonju 54896, Korea*
[3]*Department of Nanoscience and Nanotechnology, Jeonbuk National University, Jeonju 54896, Korea*
[4]*Textile Engineering, Chemistry and Science, North Carolina State University 2401 Research Dr. Raleigh, NC 27695-8301, USA*

Abstract

We have designed a nanocomposite of silver nanoparticle and carbon nanospheres (AgNPs/CNSs) as a catalyst for the rapid degradation of organic pollutants. The photocatalytic performance of the nanocomposite was examined by evaluating the degradation of methylene blue (MB) under UV light irradiation. The degradation percentages of the pollutant dye (MB) are: AgNPs/CNSs (~90.82%), AgNPs (~80.18%) under UV irradiation for 60 min. Furthermore, stability performance is studied by recycling the AgNPs/CNSs composite. It is found that the photocatalytic activity of AgNPs/CNSs composite is slightly decreased even after five cycles. In a nutshell, this novel composite AgNPs/CNSs exhibit time-dependent remarkable catalytic activity under UV light irradiation.

Results

XRD & FT-IR

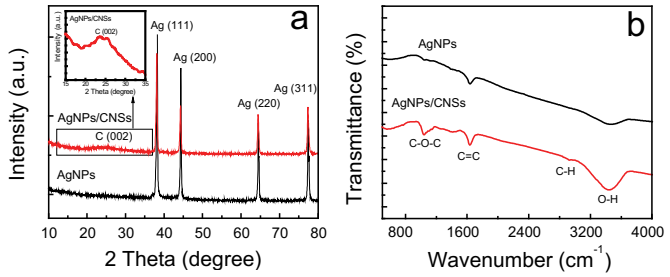

Figure 1. (a) XRD pattern and (b) FT-IR spectrum of the AgNPs and composite AgNPs/CNSs

UV-Visible

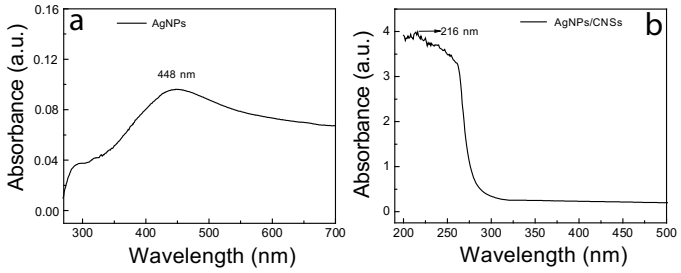

Figure 2. UV spectrum of the (a) AgNPs and (b) composite AgNPs/CNSs

HR-TEM

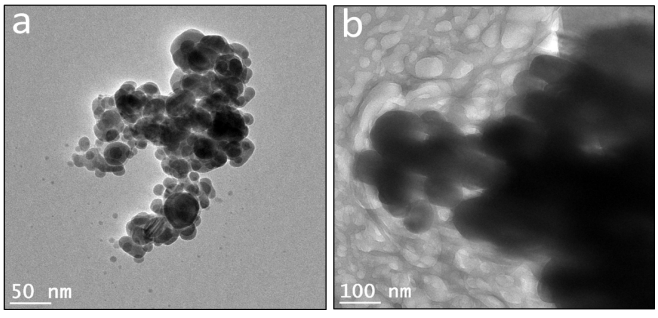

Figure 3. HR-TEM images of the (a) AgNPs and (b) composite AgNPs/CNSs

Application

Photocatalytic Action

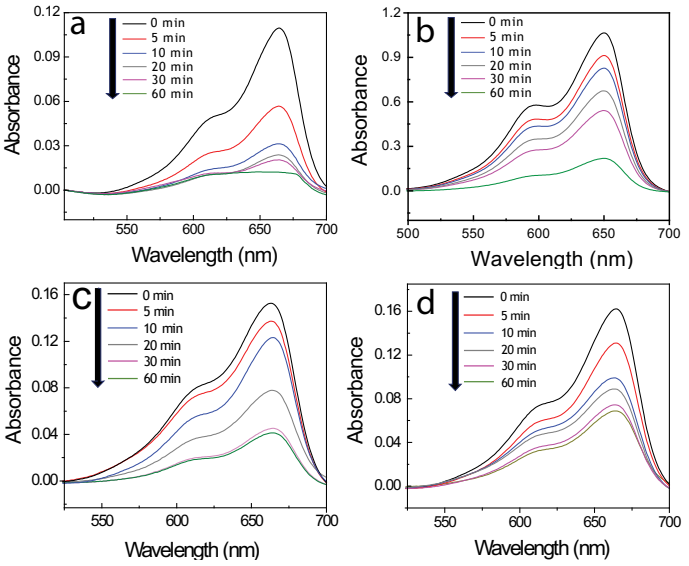

Figure 4 UV-vis absorbance spectra of methylene blue degradation as a function of time in the presence of (a) AgNPs/CNS, (b), AgNPs (c), precursor silver acetate, (d) MB decomposition in the absence of catalyst.

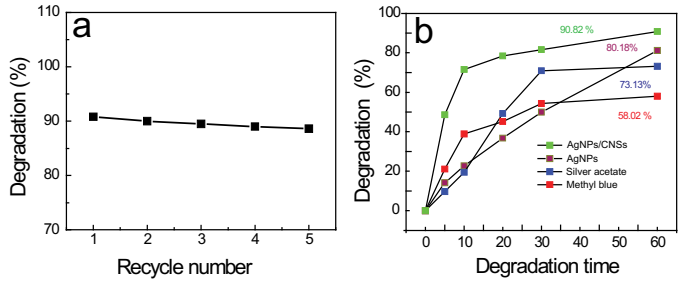

Figure 5. (a) Recycling performance of the AgNPs/CNSs and (b) Organic pollutant dye degradation percent by using, AgNPs/CNSs, AgNPs, silver acetate, and methyl blue without catalyst.

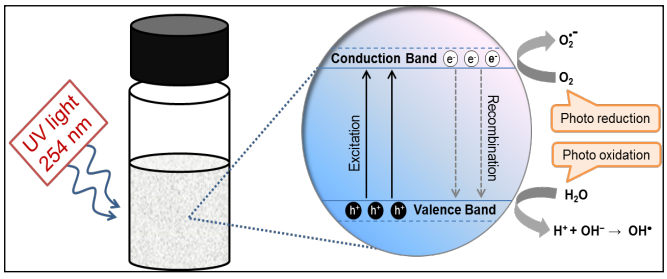

Figure 6. proposed photocatalytic mechanism of AgNPs/CNSs for the catalytic degradation of methyl blue dye

Summary

- a simple and effective method is proposed for synthesis of the AgNPs and AgNPs/CNSs composite.
- It is found that as-synthesized AgNPs/CNSs composite can degrade higher methylene blue dye (~90.82 %) after 60 min of UV irradiation in comparison with that of AgNPs.
- Furthermore, AgNPs/CNS composite can easily be recycled for photocatalytic purpose. It is found that the photocatalytic activity of AgNPs/CNSs composite is slightly decreased even after five cycles
- composite AgNPs/CNSs is a promising material as a photocatalyst for degradation of dyes in water for future industrial applications.