Synthesis of Visible Light Active Mesoporous Ag-WO_3/SBA-15 Nano Composite Catalyst Based on Surface Plasmon Resonance Enhanced Process

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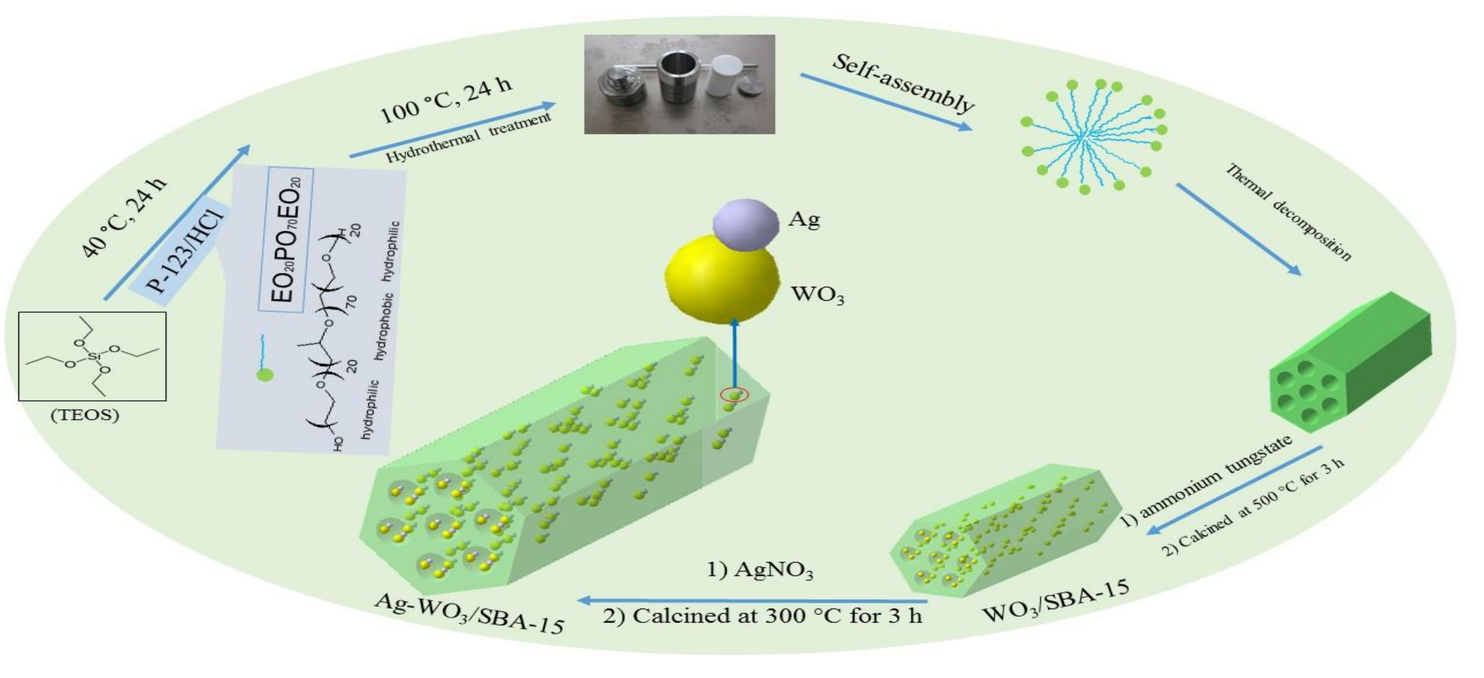
Abstract

Visible-light-driven photocatalysts have received significant attention because visible light is much more abundant in the solar spectrum (ca. 46%) than UV light In this work, we developed a photocatalytic method for the degradation of Atrazine in water samples In this work, we improved the photocatalytic function of WO_3 by introducing two modifications: (i) enhancing its surface area by impregnation onto SBA-15 template and (ii) doping it with the noble metal Ag to reduce the electron-hole pair recombination and to induce surface plasmon resonance for enhancing the generation of charge carriers. The modified WO_3, labeled as Ag-WO_3/SBA-15 was tested as a photocatalyst for the degradation of atrazine in water and its photocatalytic activity was compared with commercial WO_3 and undoped WO_3/SBA-15

Keywords: Photocatalysis, nanocomposite, Degradation of Herbicide.

Methods and Materials

◆ Synthesis Scheme of of Ag-WO_3/SBA-15



Results

Properties of SBA-15, WO_3/SBA-15 and Ag-WO_3/SBA-15 samples

◆XRD patterns for the catalysts

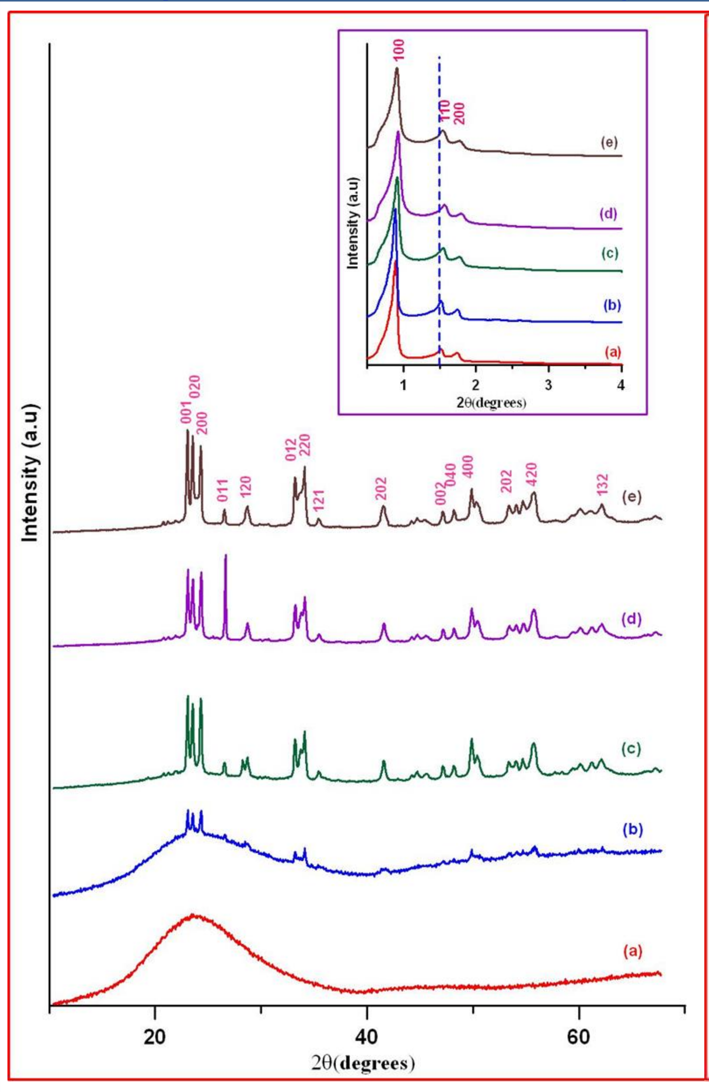


Fig.1 XRD patterns of (a) SBA-15 (b) 10% WO_3/SBA-15 (c) 20% WO_3/SBA-15 (d) 30%WO_3/SBA-15 and (e) 40% WO_3/SBA-15. Inset shows the small-angle XRD for the same composites in the same order (a) to (e).

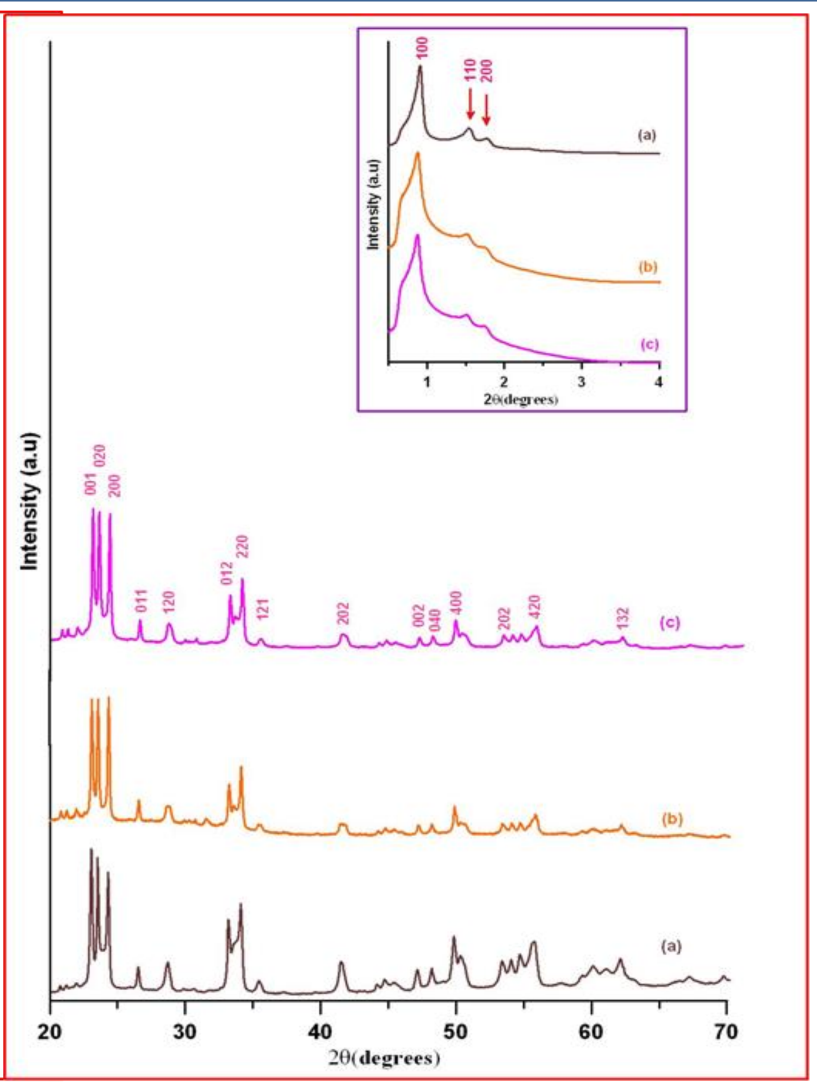


Fig.2 XRD patterns of Ag-loaded WO_3-SBA-15 composites (a) 40% WO_3/SBA-15 (b) 0.5% Ag in 40% WO_3/SBA-15 and (c) 1% Ag in 40% WO_3/SBA-15. Inset shows the Small-angle XRD for the same composites in the same order (a) to (c).

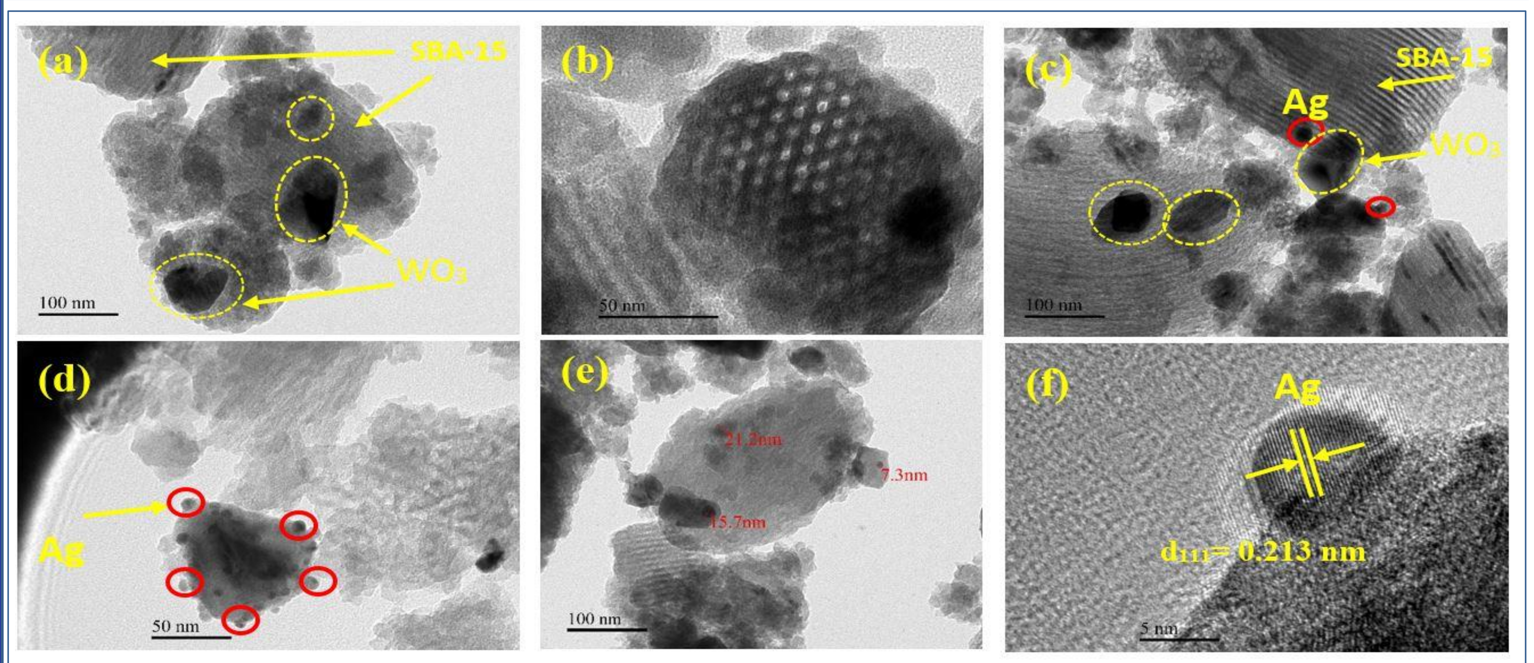


Fig.3 TEM images of low and high magnification mesoporous (a) 40% WO_3/SBA-15 (c-e) 1% Ag in WO_3/SBA-15 (f) d-spacing.

Properties of SBA-15, WO_3/SBA-15 and Ag-WO_3/SBA-15 samples

Sample	S_{BET}/ (m^2g^{-1})	Vp (cm^3 g^{-1})	Band gap (eV)	Rate Cons. (K) min $^{-1}$
SBA-15	603	0.93	-	-
10%WO_3/SBA-15	542	0.88	3.0	0.001
20%WO_3/SAB15	560	0.87	2.5	0.010
30%WO_3/SBA-15	495	0.75	2.5	0.021
40%WO_3/SBA-15	344	0.56	2.4	0.024
0.5%Ag/40%WO_3/SBA-15	231	0.43	1.7	0.036
1.0% Ag/40%WO_3/SBA-15	208	0.43	1.7	0.065

S_{BET} surface area, Vp pore volume.

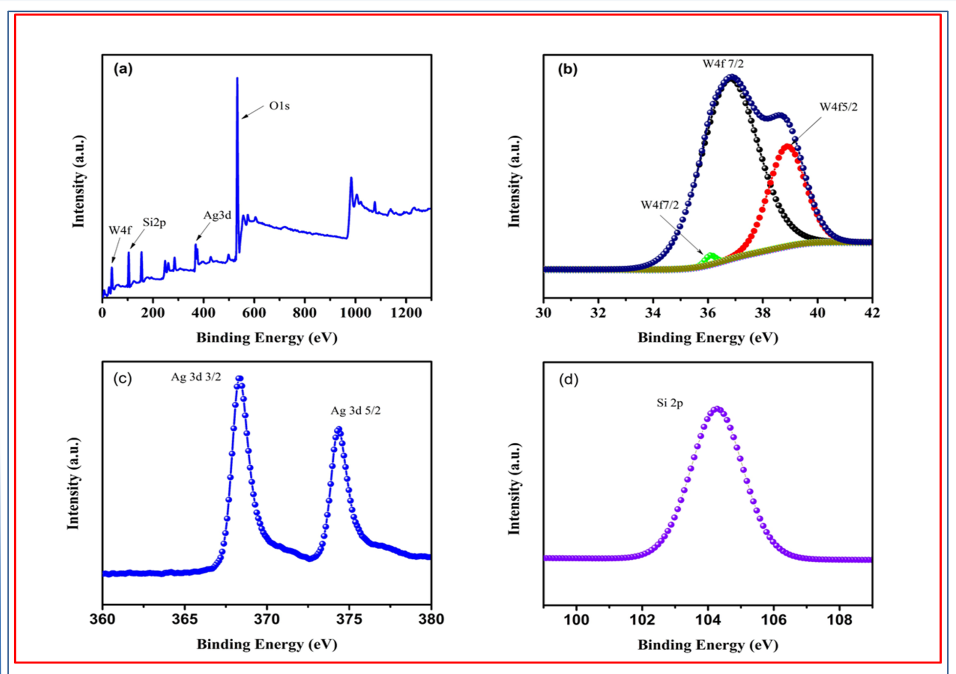


Fig. 4 XPS spectra of (a) survey of the sample, (b) W 4f, and (c) Ag 3d (d) Si 2p of the 0.5% Ag-WO_3/SBA-15.

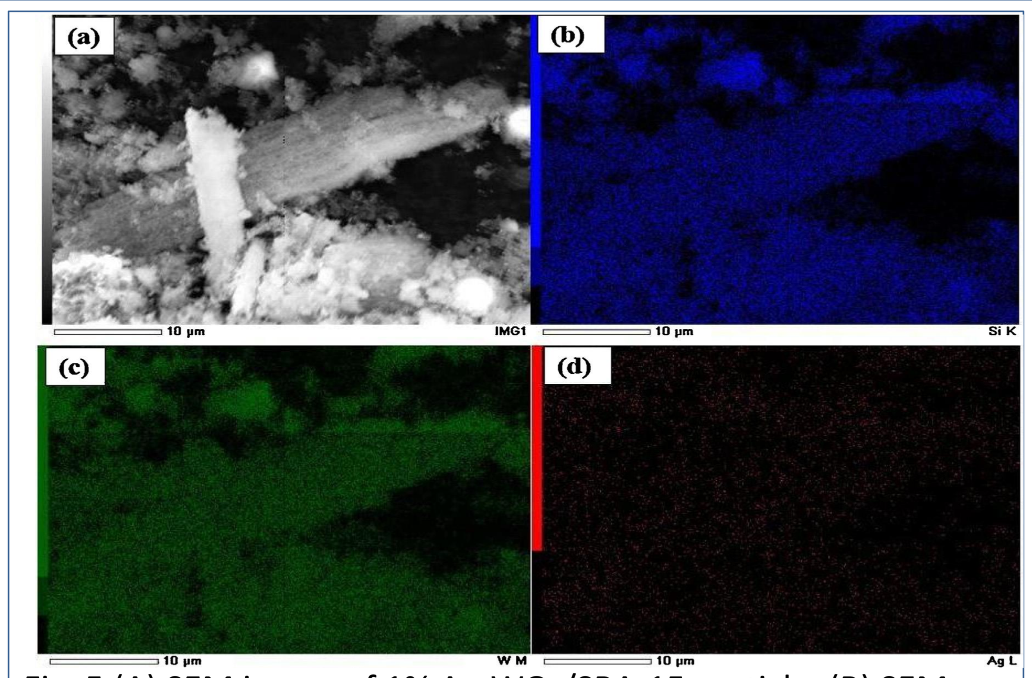


Fig. 5 (A) SEM image of 1% Ag-WO_3/SBA-15 particle, (B) SEM-EDX elemental mapping image of Si(K) on this area, (C) SEM-EDX elemental mapping image of W(M) on this area, (D) SEM-EDX elemental mapping image of Ag(L) on this area.

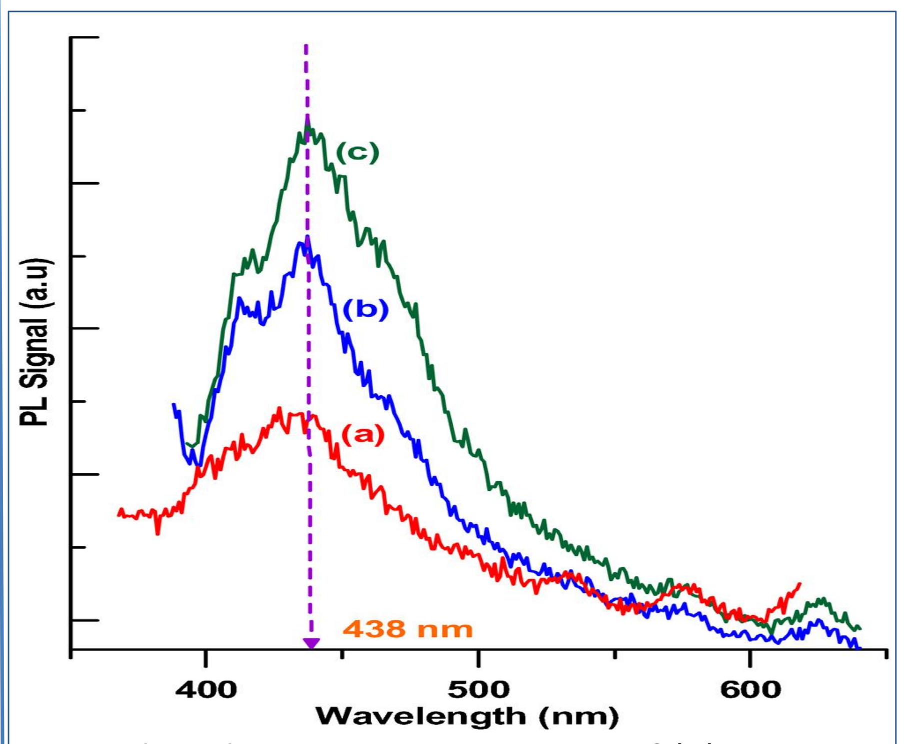


Fig.6 Photoluminescence spectra of (a) 1% Ag in 40% WO_3/SBA-15, (b) 0.5% Ag in 40% WO_3/SBA-15 (c) 40% WO_3/SBA-15.

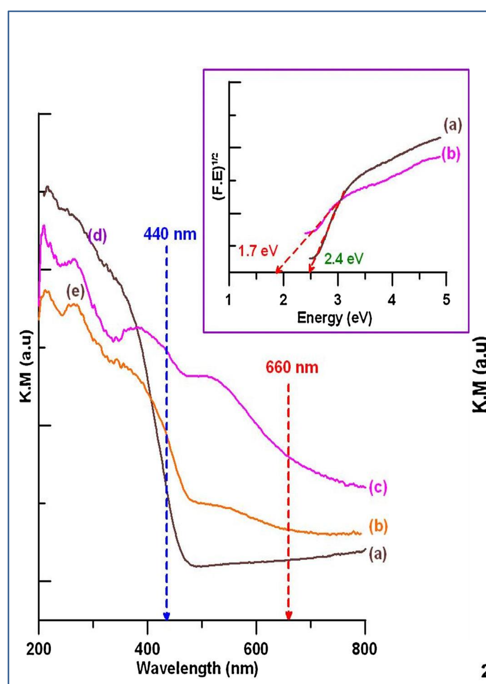


Fig.7 DRS represented as Kubelka-Munk Function for (a) 40% WO3/SBA-15 (b) 0.5% Ag in 40% WO3/SBA-15 (c) 1% Ag in 40% WO_3/SBA-15. Inset shows the Tauc plots for the same composites in the same order (a) to(b).

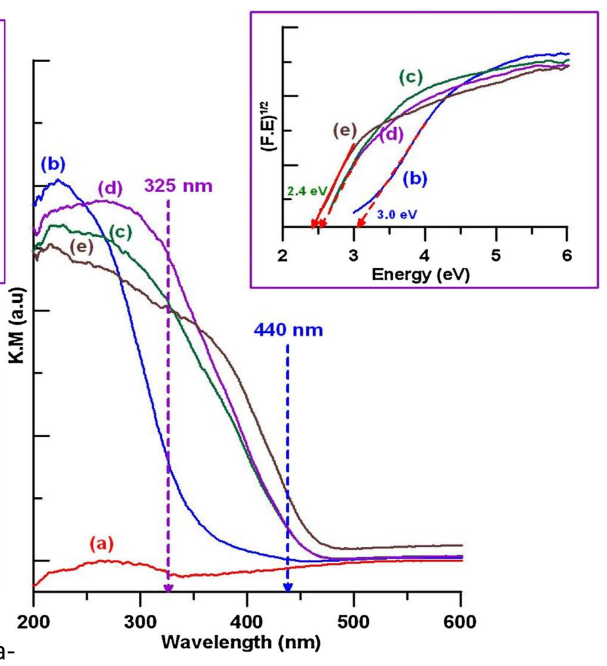


Fig.8 DRS represented as Kubelka-Munk function for(a) SBA-15 (b) 10% WO_3/SBA-15 (c) 20% WO_3/SBA-15 (d) 30% WO_3/SBA-15 and (e)40% WO_3/SBA-15. Inset shows the Tauc plots for the same composites in the same order (b) to (e).

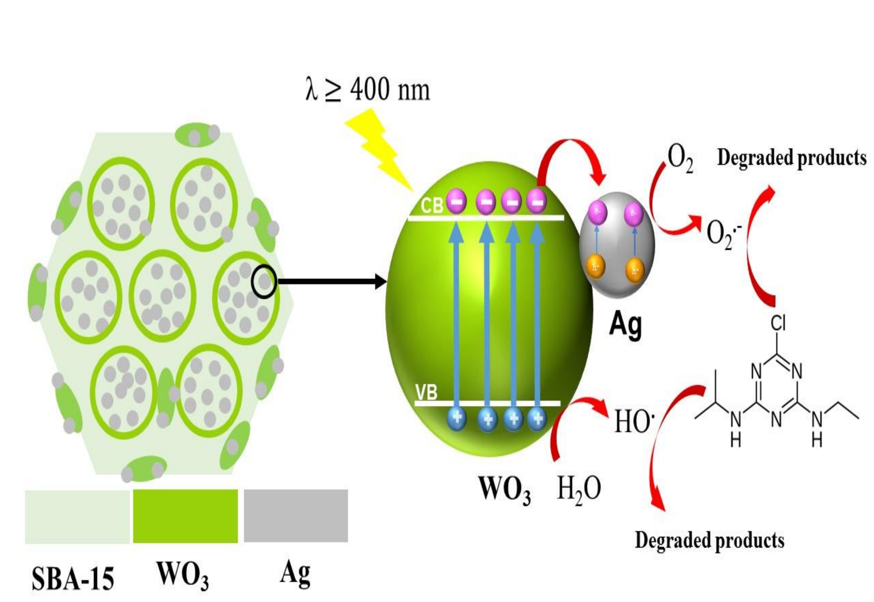


Fig. 8 Proposed photocatalytic degradation process at the surface Ag-WO_3/SBA-15.

Conclusions

Loading of Ag-WO_3/SBA-15 catalysts can efficiently degrade ~70% of atrazine in 18 min of visible light irradiation

Silver into the WO_3/SBA-15 promotes photoactivity in the visible spectral region and significantly reduced the electron hole recombination.

Mesoporous Ag-WO_3/SBA-15 catalysts can be considered as prospective candidates for advanced oxidation process in wastewater treatment.

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