PHOTOCATALYTIC DEGRADATION OF VALSARTAN BY MoS_2/BiOCl HETEROJUNCTIONS

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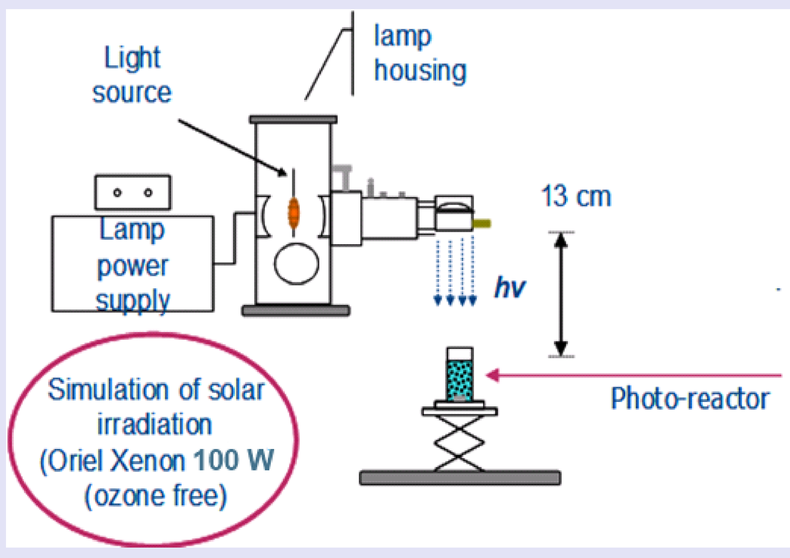
Scope

- Pharmaceuticals are designed to stimulate a physiological response in humans, animals, bacteria or other organisms.
- Semiconductor photocatalysis using solar irradiation as the source of photons for the activation of the catalyst has received considerable attention over the past few years.
- Bismuth-based materials have shown some promise in the photocatalytic degradation of organic dyes and pharmaceuticals, as under UV light irradiation BiOCl is a potential photocatalyst which may compete with TiO_2, even though its band gap is larger than 3.2 eV.
- Molybdenum disulfide (MoS_2) is a silver black solid that is similar to graphite. Up to now, no report has discussed the preparation and properties of BiOCl combined with MoS_2 and their application in the degradation of pharmaceuticals.
- The effect of various operating conditions such as VLS and catalyst concentration, initial solution of pH, irradiation type (visible, UV) and water matrix has been examined.

Experimental



Photocatalyst: MoS_2/BiOCl

Light source: Xe-arc lamp (Oriel LCS-100W)

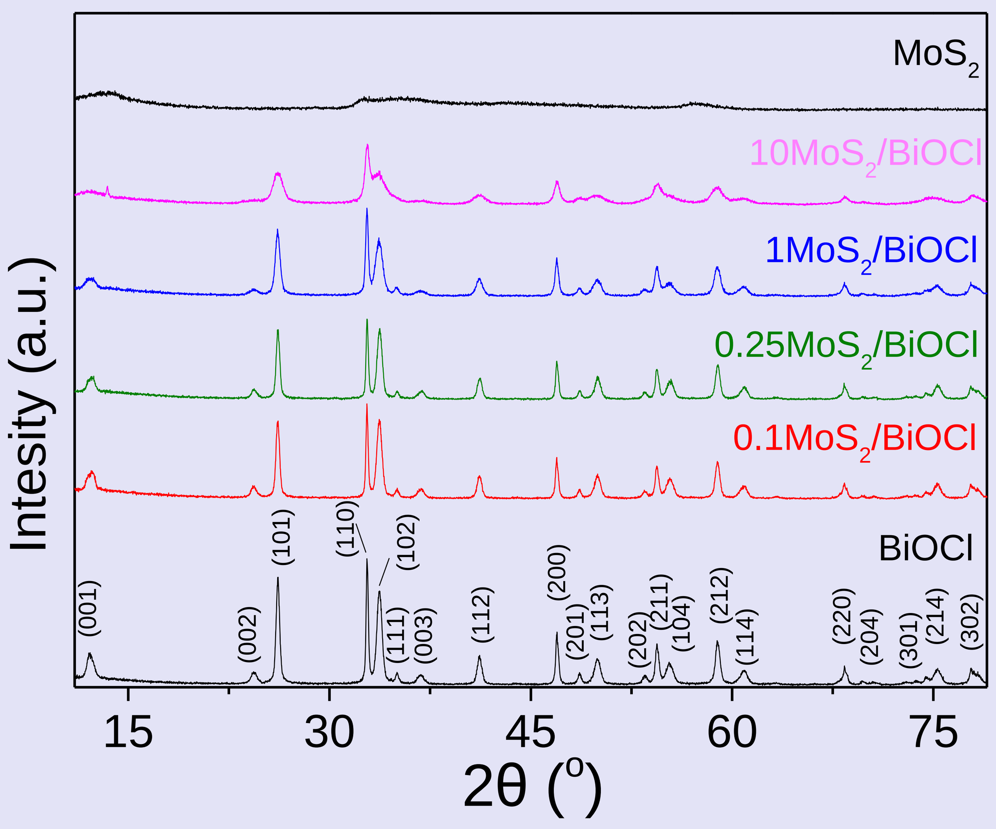
V= 60 mL

HPLC Waters Alliance 2695 system

- ✓ Waters 2996 PDA Detector 230 nm.
- ✓ Kinetex XB-C18 100A column (2.6 μm, 2.1 mm × 50 mm) & 0.5 μm inline filter
- ✓ 65:35 UPW:acetonitrile 0.2 mL/min and 45 °C

Results

Catalyst Characterization

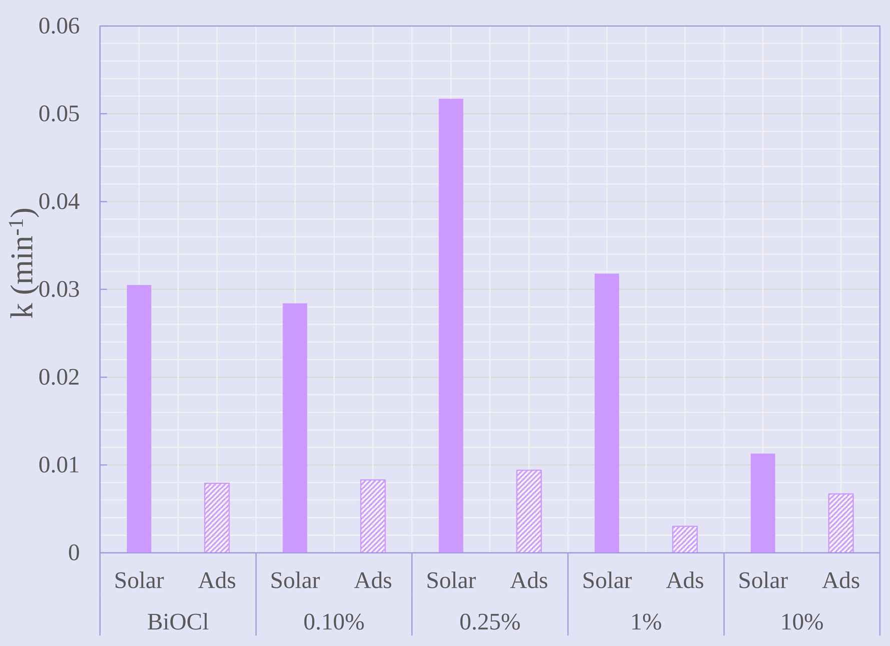


X-ray diffraction patterns of MoS_2/BiOCl photocatalysts

Sample	SSA (m^2g^{-1})
MoS_2	5
10% MoS_2/BiOCl	38
1% MoS_2/BiOCl	27
0.25% MoS_2/BiOCl	20
0.1% MoS_2/BiOCl	18
BiOCl	21

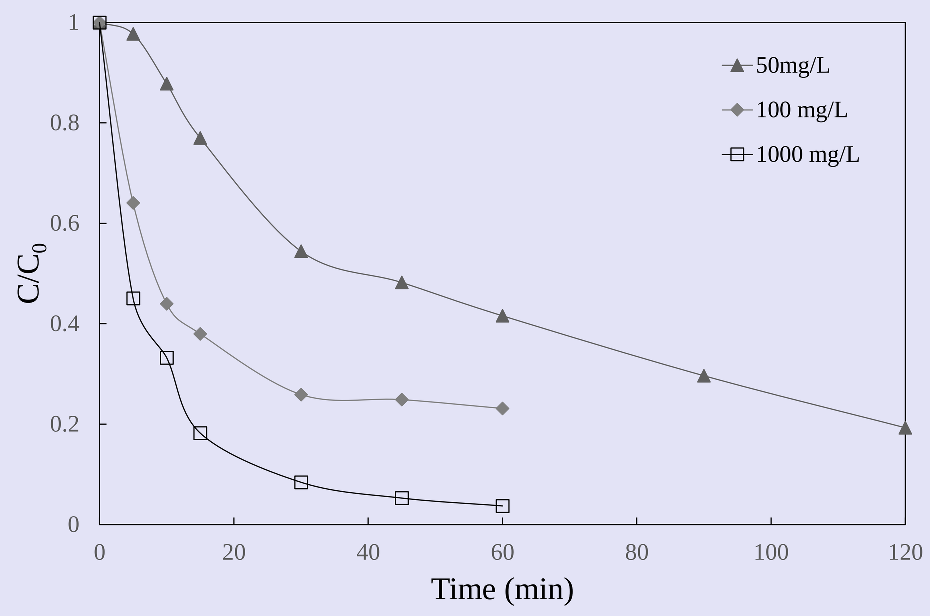
Specific surface area, determined with the B.E.T. method.

From preliminary experiments the 0.25% MoS_2/BiOCl photocatalyst showed higher efficiency for the degradation of valsartan than pure BiOCl. The enhanced photocatalytic activity over MoS_2 composites was mainly attributed to better electron-hole separation.

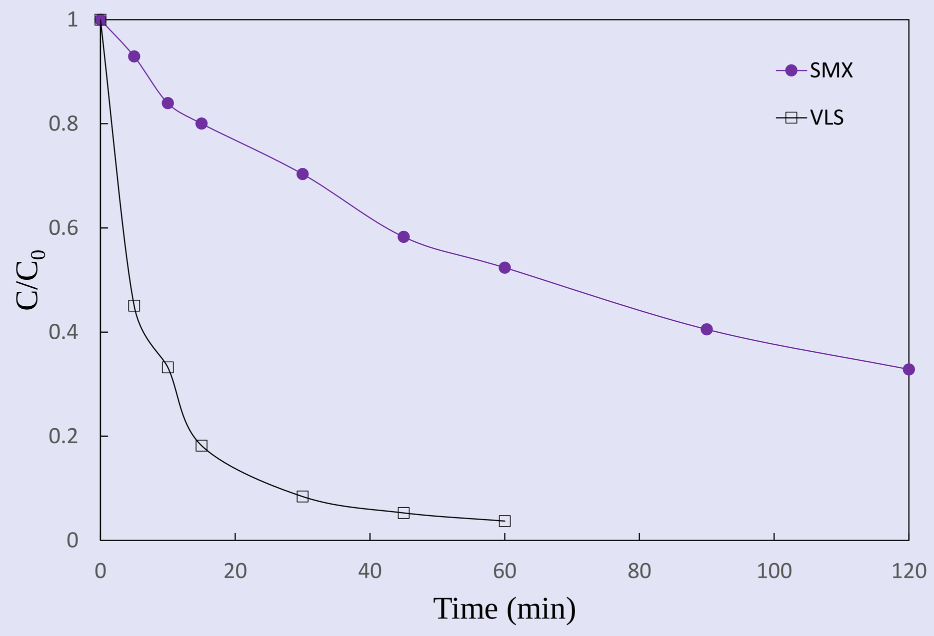


Difference between the activity of MoS_2/BiOCl composites with different mass ratios under solar irradiation and adsorption

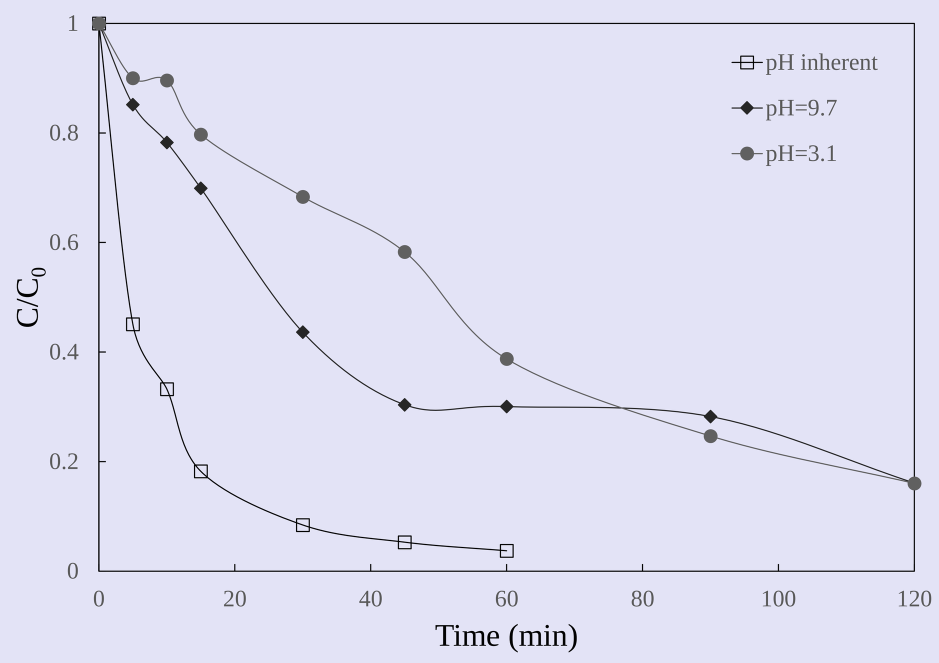
Photocatalytic Experiments



Effect of 0.25% MoS_2/BiOCl loading on 0.5 mg/L VLS degradation in ultrapure water and inherent pH.



Comparison on the degradation of different pharmaceuticals under solar irradiation with 1000 mg/L 0.25% MoS_2/BiOCl catalyst in ultrapure water and inherent pH.

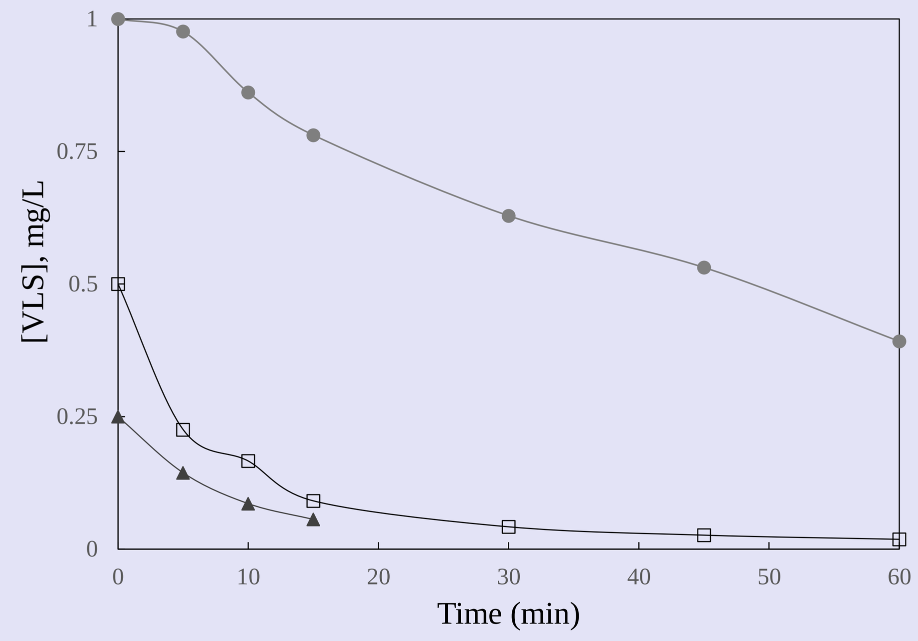


Effect of pH on 0.5 mg/L VLS degradation with the use of 1000 mg/L 0.25% MoS_2/BiOCl in ultrapure water.

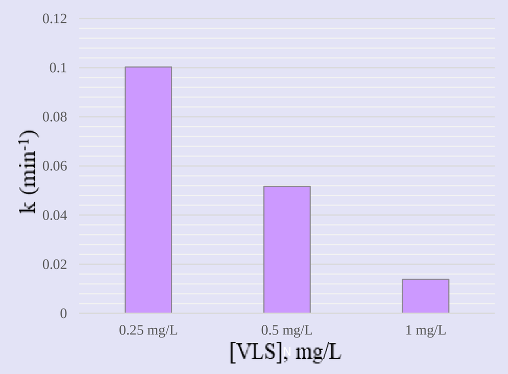
VLS degradation is assumed to follow a pseudo-first order kinetic expression, according to Eqn. (1)

$$C_t = C_0 \exp(-kt) \quad (1)$$

where, k is the computed apparent constant rate, C_t and C_0 are referred to the VLS concentration at time t and zero, respectively.

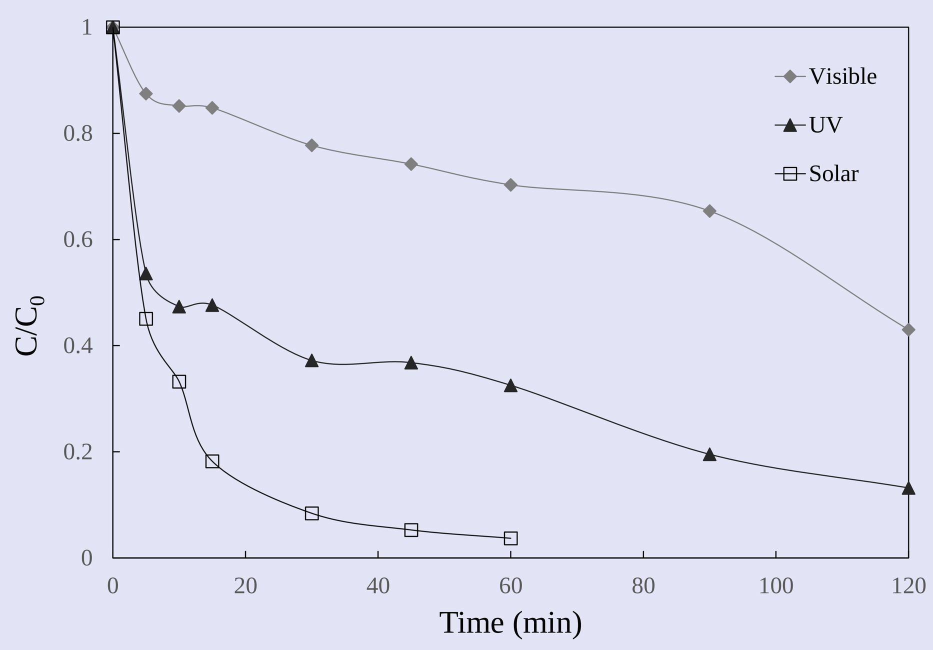


Effect of VLS concentration with the use of 1000 mg/L 0.25% MoS_2/BiOCl in ultrapure water.

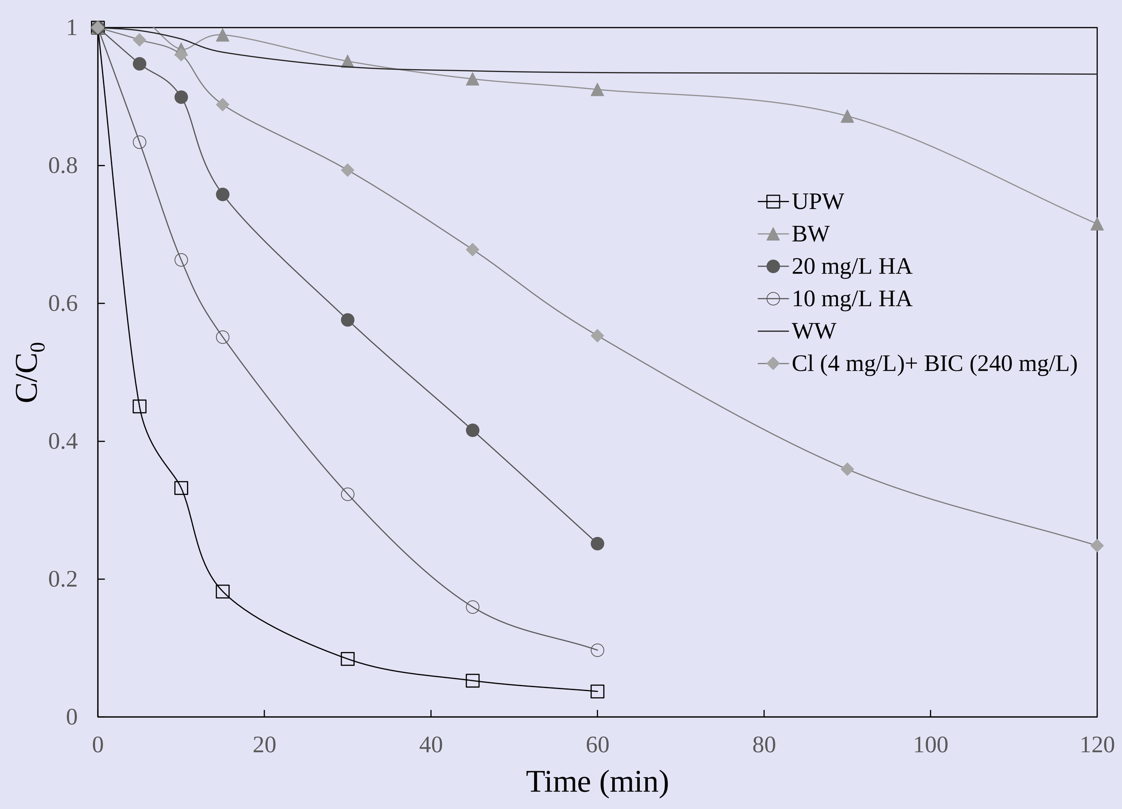


VLS (mg/L)	R^2
0.25	0.9968
0.5	0.9176
1	0.9932

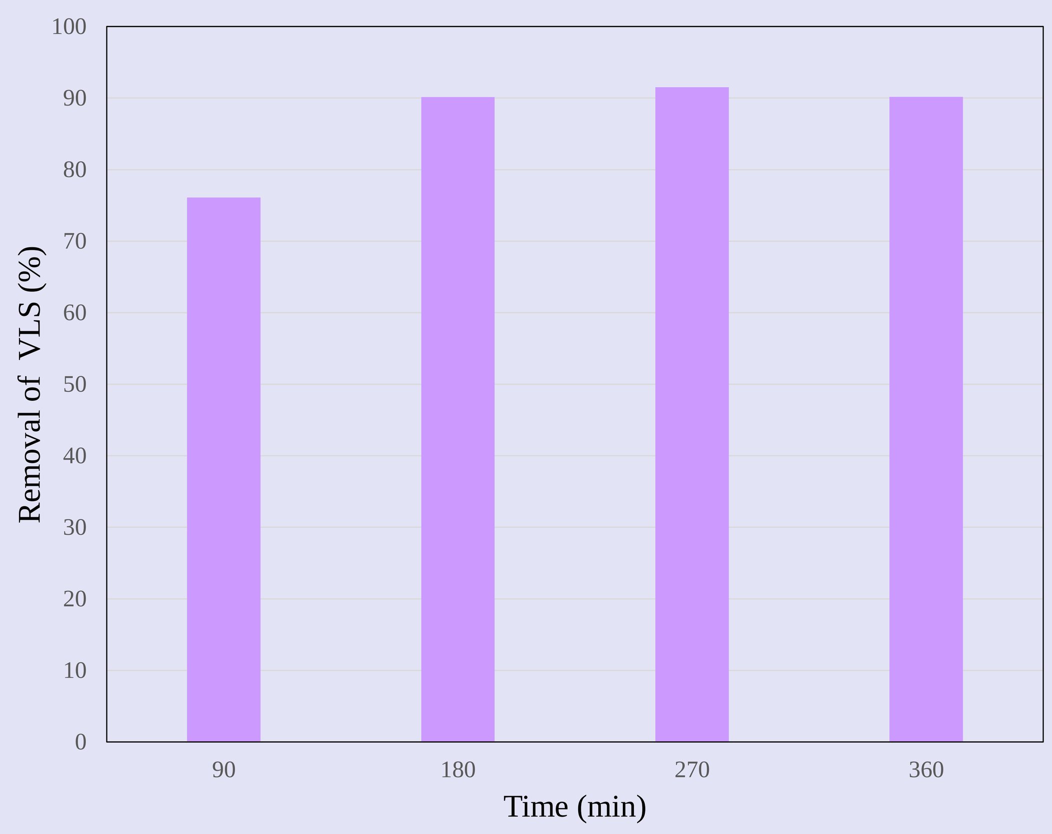
Comparison of apparent constants rate of different VLS concentration with the use of 1000 mg/L 0.25% MoS_2/BiOCl in ultrapure water.



Effect of irradiation on 0.5 mg/L VLS degradation with the use of 1000 mg/L 0.25% MoS_2/BiOCl in ultrapure water and inherent pH.



Effect of water matrix with the use of 1000 mg/L 0.25% MoS_2/BiOCl in inherent pH.



Removal of 0.5 mg/L VLS after 90 min of reaction for 4 consecutive runs with 1000 mg/L catalyst under solar irradiation.

Conclusions

➢Semiconductor photocatalysis based on MoS_2/BiOCl is an efficient method for the degradation of VLS in aqueous solutions under solar radiation.

➢Process performance was affected by several factors, such as irradiation time and type, catalyst concentration, VLS concentration, pH and water matrix. The optimum loading of MoS_2/BiOCl was found to be 1000 mg/L.

➢Complex interactions between the catalyst and the various inorganic and organic species present in aqueous matrices retard VLS degradation. VLS removal efficiency was higher at an inherent pH.

➢0.25% MoS_2/BiOCl photocatalyst exhibits excellent stability as complete VLS removal takes place after the reuse of the same catalyst for four times.