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Efficient photocatalytic degradation of nadolol using silver-modified PMMA/TiO_2

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INTRODUCTION & AIM

Nadolol, a commonly used β-blocker, is frequently detected in wastewater, posing an environmental issue. Photocatalysis, particularly with TiO_2, has been explored as a solution for such pollutants, but TiO_2's effectiveness is limited by the high recombination rate of electron-hole pairs. To enhance its photocatalytic performance, TiO_2 is often modified using polymers like poly(methyl methacrylate) (PMMA), which is low-cost, non-toxic, and water-insoluble. In this study, PMMA was modified with silver and combined with TiO_2 nanopowder to degrade nadolol under UV-LED radiation.

METHOD

To prepare 10 wt% Ag-doped PMMA, $AgNO_3$ was dissolved in ultrapure water. PMMA polymer powder was then gradually added to resulting solution and mixture was stirred for 4 h at room temperature. After standing overnight, the precipitate was dried at 80 °C for 2 h. TiO_2 with 10 wt% Ag-PMMA (Ag-PMMA/TiO_2) was prepared by mixing TiO_2 and Ag-PMMA powders for 30 min.
The degradation kinetics were monitored using high-performance liquid chromatography, and the pH changes was observed using a pH meter.

RESULTS & DISCUSSION

After 120 min of UV-LED irradiation, the Ag-PMMA/TiO_2 material showed significantly higher removal efficiency of nadolol compared to direct photolysis and degradation using Ag-PMMA. Namely 94 % removal efficiency of nadolol significantly outperforming direct photolysis and Ag-PMMA treatment (Figure 1).

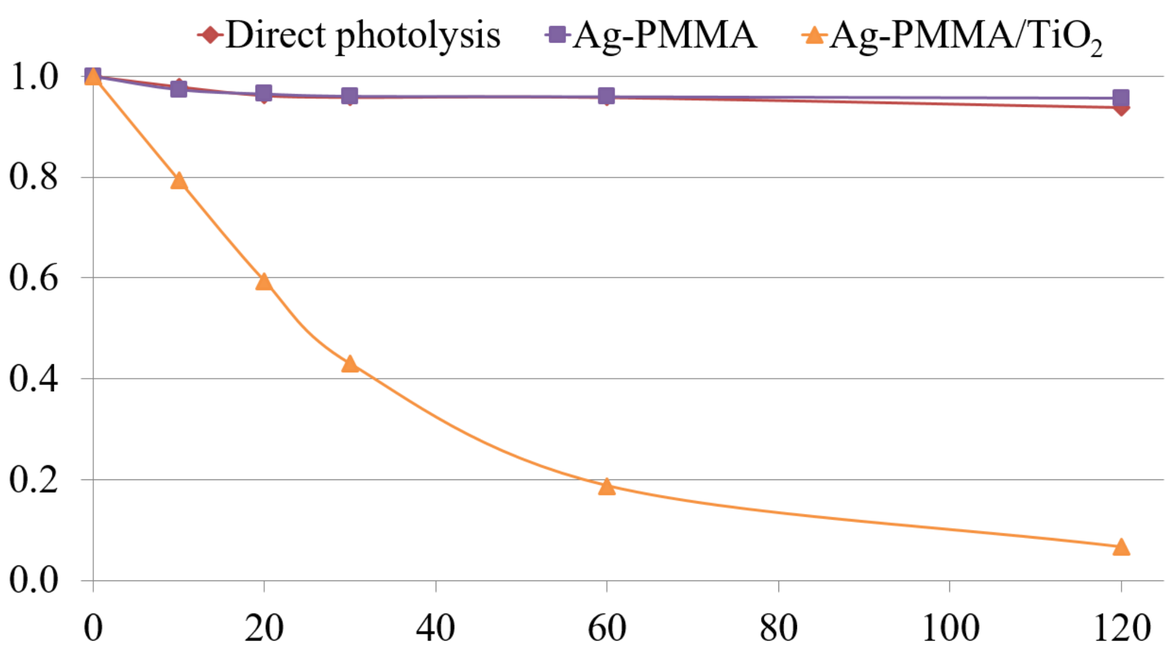

Figure 1. The kinetics of nadolol degradation under UV-LED radiation

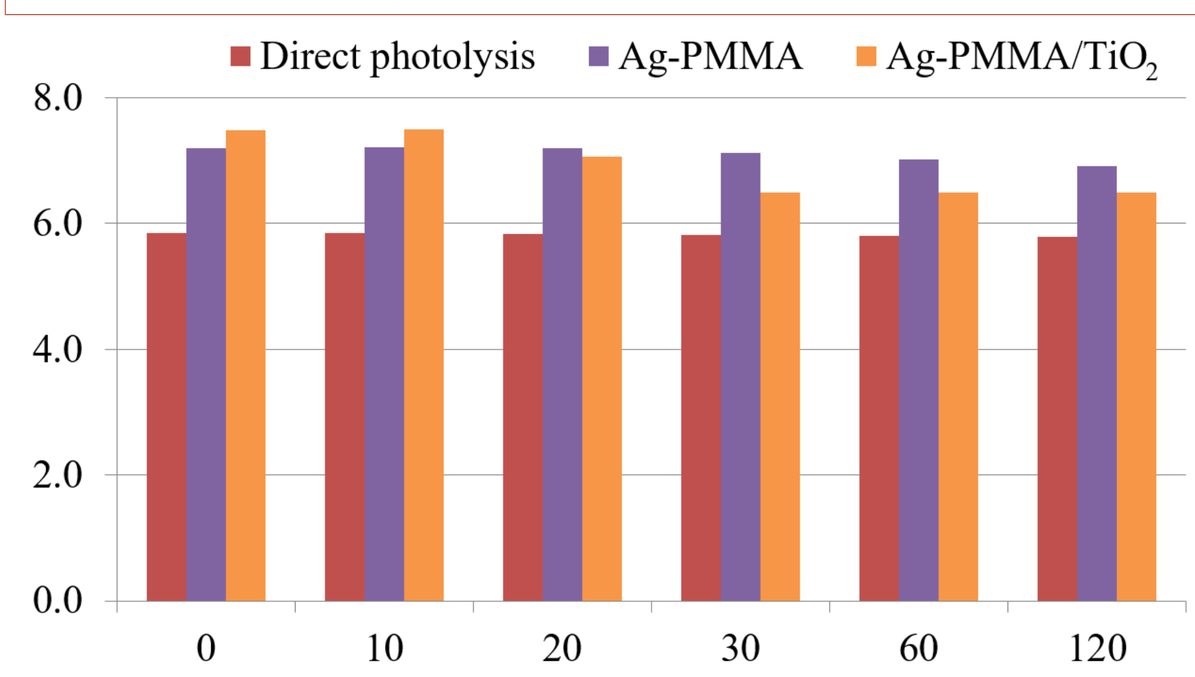

Figure 2. The pH change during nadolol degradation under UV-LED radiation

The pH changes during the experiments were monitored, showing that the catalyst presence influenced the pH values (Figure 2). During photocatalytic degradation, the pH decreased slightly from 7.5 to 6.5 for Ag-PMMA/TiO_2, indicating the formation of acidic intermediates. The degradation followed pseudo-first-order kinetics, as evidenced by the calculated rate constant of $19.1 \cdot 10^{-3}$ 1/min with the linearity correlation coefficients of 0.9973 for the first 30 min of degradation.

CONCLUSION

The results indicated that Ag-PMMA/TiO_2 is efficient in the photodegradation of nadolol, achieving a 94% degradation rate within 120 minutes. The photocatalytic degradation of nadolol followed the pseudo-first order. The observed photocatalytic activity demonstrated the practical applicability of the novel materials.

ACKNOWLEDGEMENTS

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