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Plasma-catalysis technologies for environmental pollutions removal

Nan Jiang, Jie Li, Bangfa Peng
School of Electrical Engineering, Dalian University of Technology, Dalian 116024, China
e-mail (speaker):jiangnan@dlut.edu.cn

As one of advanced oxidation technologies (AOTs), non-thermal plasma (NTP) has been deemed as one of the most promising technologies for contaminant treatment in the past few years, including wastewater remediation, exhausted gas abatement and solid-waste disposal because of the presence of abundant of energetic electrons and chemical reactive species, such as ·O, ·OH, O^{2+}, H_3O^+, O_2^-, O_3, etc. However, the energy efficiency and the selectivity towards the desired non-toxic products via complete mineralization is still low by using plasma-only process. A more approach to deep exploit the potential of plasma is combining plasma with catalysis. The plasma-catalysis process can integrate the advantage of the quick response from plasma and high selectivity of desired products from catalysis. The paper introduces the plasma-catalysis approaches for organic wastewater treatment and volatile organic compounds (VOCs) removal at ambient temperature.

1) Organic wastewater treatment: The hybrid rGO-TiO_2 is prepared and combined with gas-liquid pulsed discharge plasma (PDP) for synergetic treatment of flumequine (FLU) wastewater[1]. The degradation performance experiment manifests a significant enhancement of the removal efficiency of FLU when rGO-TiO_2 samples are added in the PDP system. The highest removal efficiency can reach 99.4% in PDP/graphene-TiO_2 system, which is 23.7% and 34.6% higher than that in PDP/TiO_2 system and sole PDP system, respectively. The radical species trapping test suggests that ·OH, h^+, and $·O_2^-$ play the critical role for FLU degradation in PDP/graphene-TiO_2 system. The graphene-TiO_2 samples can further decompose the O_3 and improve the generation of ·OH and H_2O_2. This research would provide a novel insight into the application of graphene-based nano-composites in PDP system as a promising remediation methodology for organic contaminants in water.

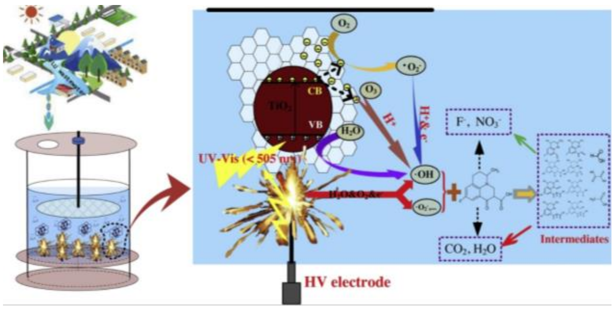

Figure 1. The degradation of fluoroquinolone antibiotic in pulsed discharge plasma with graphene-TiO_2 nanocomposites

2) VOCs removal: Plasma-assisted catalytic degradation of xylene was performed in a pulsed sliding dielectric barrier discharge (SLDBD) reactor based on three-electrode geometry over bimetallic oxides catalysts[2,3]. The surface potential difference between the pulsed excited high-voltage and the negatively biased third electrodes ($U_{pulse-DC}$) is the major cause for streamers propagation because of the increased electric field at the streamer head. The VOC degradation efficiency and energy yield are significantly improved when $U_{pulse-DC}$ exceeds 20 kV where an SLDBD plasma is ignited, which can be attributed to the promoted surface streamers propagation as well as greater number of chemical active species. The combination of SLDBD plasma with catalysts significantly improved the VOCs degradation efficiency and CO_2 selectivity than the plasma-only system, and the activity of catalyst was closely correlated with the location of catalyst in plasma, the content and molar ratio of active metal components.

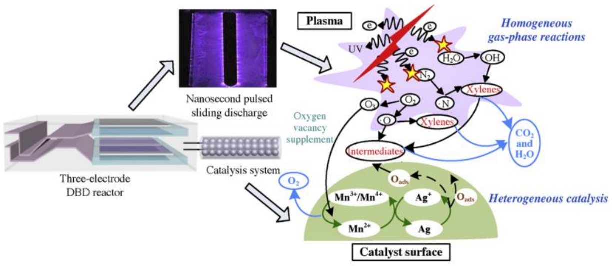

Figure 2. Plasma-catalytic destruction of xylene over Ag-Mn mixed oxides in a pulsed sliding discharge reactor

References

1. H. Guo, N. Jiang, H. Wang, et al. Applied Catalysis B: Environmental, 248 (2019) 552-566.
2. N. Jiang, K. Shang, X. Lu, et al. Journal of Cleaner Production 332 (2022) 129998.
3. N. Jiang, C. Qiu, L. Guo, et al. Journal of Hazardous Materials 369 (2019) 611-620.

Note: Abstract should be in (full) double-columned one page.