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Enhancing photocatalytic activity of zinc oxide nanoparticles by a non-thermal atmospheric pressure plasma

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Abstract

In this work, plasma has been used as a simple, very fast, low energy and efficient method for modification of the zinc oxide nanopowder to improve its photocatalytic activity. Zinc oxide is one of the effective photocatalysts in degradation of the organic contaminants, e.g. dyes. The purpose of the zinc oxide photocatalyst modification is to reduce the band gap and thus to increase its photocatalytic activity in the visible light range. To achieve nitrogen-doped zinc oxide nanoparticles (N-Doped ZnO), the zinc oxide nanopowder was suspended in melamine solution, as nitrogen precursor, and then treated with a non-thermal atmospheric pressure plasma. Different concentrations of melamine and different times of plasma exposure were considered for optimizing the nitrogen-doped zinc oxide structure. The photocatalyst properties of the pure zinc oxide and optimized nitrogen-doped zinc oxide samples were investigated by XRD, FESEM, EDX, BET, DRS and PL analyses. The photocatalytic activity of the pure zinc oxide nanopowder and plasma-treated samples were performed in the photocatalytic degradation of methylene blue dye contaminant. The degradation efficiency of methylene blue by the pure zinc oxide was 71.7%. By applying plasma to the zinc oxide nanopowder for 5 minutes with a concentration of 500 mg/L of melamine solution, the degradation efficiency was enhanced to 90%. According to the results, it can be seen that the plasma treatment has succeeded in the nitrogen doping process to the zinc oxide structure and improved its photocatalytic activity.

Keywords: atmospheric pressure plasma, dielectric barrier discharge, photocatalyst, zinc oxide

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