World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:06, 2018

Effect of Doping on Band Gap of Zinc Oxide and Degradation of Methylene Blue and Industrial Effluent

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Abstract : Effluent of dye industries contains chemicals and organic dyes. Sometimes they are thrown in the water bodies without any treatment. This leads to environmental pollution and is detrimental to flora and fauna. Semiconducting oxide zinc oxide with wide bandgap 3.37 eV is used as a photocatalyst in degrading organic dyes using UV radiations. It generates electron-hole pair on exposure to UV light. If degradation is aimed at solar radiations, bandgap of zinc oxide is to be reduced so as to utilize visible radiation. Thus, in present study, zinc oxide, ZnO is synthesized from zinc oxalate, N doped zinc oxide, $ZnO_{1-x}N_x$ from hydrazinated zinc oxalate, cadmium doped zinc oxide $Zn_{0.9}Cd_{0.10}$ and magnesium-doped zinc oxide $Zn_{0.9}Mg_{0.10}$ from mixed metal oxalate and hydrazinated mixed metal oxalate. The precursors were characterized by FTIR. They were decomposed to form oxides and XRD were recorded. The compounds were monophasic. Bandgap was calculated using Diffuse Reflectance Spectrum. The bandgap of ZnO was reduced to 3.24 because of precursor method of synthesis leading large surface area. The bandgap of $Zn_{0.9}Cd_{0.10}$ was 3.11 eV and that of $Zn_{0.9}Mg_{0.10}$ 3.41 eV. The lowest value was of $ZnO_{1-x}N_x$ 3.09 eV. These oxides were used to degrade methylene blue, a model dye in sunlight. $ZnO_{1-x}N_x$ was also used to degrade effluent of industry manufacturing colours, crayons and markers. It was observed that $ZnO_{1-x}N_x$ acts as a good photocatalyst for degradation of methylene blue. It can degrade the solution within 120 minutes. Similarly, diluted effluent was decolourised using this oxide. Some colours were degraded using ZnO. Thus, the use of these two oxides could mineralize effluent. Lesser bandgap leads to more electro hole pair thus helps in the formation of hydroxyl ion radicals. These radicals attack the dye molecule, fragmentation takes place and it is mineralised.

Keywords : cadmium doped zinc oxide, dye degradation, dye effluent degradation, N doped zinc oxide, zinc oxide
Conference Title : ICIWTC 2018 : International Conference on Industrial Waste Treatment and Control
Conference Location : London, United Kingdom
Conference Dates : June 28-29, 2018