Effect of doping nickel/cobalt ions on the structural and photocatalytic efficiency of magnesium manganese oxide materials for the environmental applications

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Abstract

The excessive use of the antibiotics like norfloxacin and their residue is a serious threat to the environment. Although photocatalysis method of removing antibiotics is considered as an efficient method, again the materials used for the above purpose should be environmentally benign and earth abundant in nature. Hence exploration of new materials and enhancing the efficiency of materials for photocatalytic degradation of the above antibiotic become an important topic of investigation. Inducing oxygen vacancies in an environment-benign compound like $MgMn_2O_4$ through low concentration of transition metal ion doping and their advantageous changes in optical properties are favorable for the photocatalytic application. In this regard, the changes in the structural and optical properties of the $MgMn_2O_4$ compound, by doping with Ni/Co ions is explored. It is found that the nickel doping shows a high photocatalytic degradation of norfloxacin as 90–95% within 90 min under the irradiation of UV–Vis light, which is higher than the bare and cobalt ion-doped compound. This is due to the more number of oxygen vacancies as analyzed from XPS, high light absorption, and more charge separation retention characteristics, as per UV–VIS and PL studies, respectively. The $MgNi_{0.5}Mn_{1.5}O_4$ compound shows a high rate constant value of $9.25 \times 10^{-4}\ M^{-1}\ s^{-1}$ and high reusability up to four cycles and could be utilized as the efficient photocatalytic materials for wastewater remediation.