

## Enhanced Photocatalytic Degradation of Azo Dye by Metal co-doped ZnO Nanorods under Ultraviolet Light Irradiation

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Copper (Cu)–Nickel (Ni) co-doped ZnO nanorods (NRs) were synthesized via simple hydrothermal technique on fluorine-doped tin oxide (FTO) glass substrate. The structural, morphological, electrochemical and photocatalyst properties of prepared specimens were considered by SEM, XRD, electrochemical and photodegradation analyses. The SEM results showed that hexagonal wurtzite structure and high density of co-doped ZnO NRs were successfully synthesized on FTO substrate. The XRD findings indicate that crystallite size of the doped or co-doped specimens reduces due to Cu and Ni incorporation, showing that the Cu or Ni doping reserved crystal growth of ZnO nanostructure. The EIS results reveal that smaller resistance of Cu–Ni co-doped ZnO NRs than the other samples was found, which confirm the enhancement of ZnO conductivity by doping metal ions in ZnO structures because of the synergistic effect between metal and ZnO NRs. Optical absorption spectrum indicates that doping procedure increases the value of absorption in the UV-region which can be associated with the narrower band-gap of metal oxides toward the band-gap of pure ZnO. Photocatalytic behavior of Cu–Ni co-doped ZnO NRs revealed that the presence of both Cu and Ni dopants into ZnO causes the production of photoexcited electron-hole pairs in ZnO nanostructures under UV-light, which lead to significantly increased the free-carrier concentration, activated radicals and facilitated the generation of robust oxidizing hole, and finally accelerated azo dye removal and degradation. These findings show that Cu-Ni co-doped ZnO NRs with tuned optical properties can be promising candidates for applications in ceramics, optoelectronic devices and photocatalytic activity.

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**Keywords:** Photocatalyst property; Metal co-doped ZnO nanorods; Hydrothermal technique; azo dyes; Electrochemical impedance spectroscopy

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